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# FOOD PREFERENCE, ACCEPTANCE AND CONSUMPTION IN A SIMULATED, ISOLATED-DUTY STATION

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In order to study food habits in a controlled isolation environment, the food choice and consumption behavior of the crew of a simulated, isolated-duty station were measured in a nine-day experiment. All crewmembers completed food preference survey forms and kept daily food consumption diaries. Food selection and consumption (in grams) were measured for each crewmember. Crewmembers displayed a fairly common pattern of intake during a day with approximately 19% of their calories obtained from breakfast, 30% from lunch, 35% from dinner, and 16% from snacks. There appeared to be no systematic shifts in probability of

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selection for either food classes or individual items as a function of the duration of the experiment. The best general predictor of food item choice was the preferred frequency rating from a survey completed during habitation. In comparing actual and recorded food consumption, several errors were found. Errors in reporting food items were more often due to failure to record items in the diary. Errors in estimating the amount consumed tended to be over-estimations if the food item was a solid and under-estimations if the item was a liquid.

Table of Contents


Summary 1

List of Figures 4

List of Tables 5

Introduction 7

Experimental Design 8

Method 9
- Subjects 9
- Facilities, Instruments, and Provisions 10
- Procedure and Schedules 13

Results 15
- Food Consumption 15
- Food Choice 31
- Food Preference Survey 36
- Food Consumption Diary 43
  - Error in Recording the Number of Servings 48
  - Error in Weight Estimation 56
  - Estimation Error in Terms of Calories 63
  - Average Ratios of Error 66

Appendix A: Availability and Serving Size of Foods 70

Appendix B: Instructions for Consumption Diary 78

Appendix C: Food Items on Preference Survey List which were not on Menu 80

Appendix D: Item Name Changes Made to Produce the "Revised Diary" 81

Appendix E: Definitions and Formulae Used in Analysis of Diary Data 82

Appendix F: Plan of Isolation Laboratory 94

## SUMMARY

The effectiveness of isolated duty stations depends on unusually careful planning to compensate for storage and logistical limitations. This study was an attempt to provide information pertaining to food related planning for such stations. The food choice and consumption behaviors of the crew of a simulated isolation duty station were measured in detail during a nine-day experiment. The laboratory located in a university building provided isolation from the outside for two functionally separate crews. The four members of the Increw spent the nine days working on an academic task unrelated to food, and were unaware that food and food related behaviors were a primary concern of the experiment. The eight members of the Outcrew were occupied with the control and operation of the experiment and the preparation and recording of food and food related behavior. While the daily schedule of the Increw was very regular, with fixed work and leisure times and normal meal times, the schedule of the Outcrew was variable and irregular. All 12 crewmembers completed Food Preference Survey forms and kept daily Food Consumption Diaries, and complete measures of food selection and consumption were recorded for each of the 12. The food items for each meal or snack were individually selected by each crewmember from a large list of available items.

Overall caloric intake was higher than expected from available comparative data, with a consequent weight gain for many of the crewmembers. There was day-to-day variation of caloric intake for all crewmembers, but the only clear general trend was a decline in intake on the final two days. Increwmembers, with a relatively normal schedule of activities, displayed a fairly common pattern of intake during a day, with about 19% of their calories obtained from breakfast, 30% from lunch, 35% from dinner and 16% from snacks. For Outcrewmembers, with irregular schedules, the proportion of calories obtained from lunch and snacks was switched: 16% from lunch and 30% from snacks, while proportions for breakfast and dinner were the same as for Increwmembers.

There appeared to be no systematic shifts in probability of selection for either food classes or individual items as a function of the duration of the experiment. Selection of items for meals remained quite typical of the normal meal composition, even among Outcrewmembers with irregular schedules. The items which were ordered more than once by at least 25% of the 12 crewmembers were also generally from food classes with the highest overall probabilities of selection.

In this experiment then the best general predictor of food item choice was the preferred frequency rating score from a Survey completed during habitation. The extent to which this superiority over hedonic preference scores would occur in a longer habitation, or with a more limited menu, simply cannot be determined from these data, although it is likely that the hedonic preference rating scores correlations were artifactually reduced by the design of this experiment. Even in this experiment, however, the correlations between food choice and hedonic preference scores from the second and third Surveys (during habitation) were higher than those from the first Survey (before habitation).

In comparing actual and recorded food consumption, errors were found both in reporting the consumption of a food item and in estimating the amount consumed. Several factors influence the occurrence of these errors. An error in reporting a food item was more often due to a failure to record that food item in the diary, and generally a structured and regular work schedule increased the accuracy with which food items were reported. Errors in estimating the amount consumed tended to be overestimations if the food item was a solid and tended to be underestimations if the food item was a liquid. The estimated amount of a liquid, which may have been determined by the volume of the container in which it was served, was generally more accurate than the estimated amount of a solid, but this varied according to the specific gravity of the liquid. The differences between the amount of calories actually consumed and the estimated amount of calories derived from the weight estimations, also depended largely upon the consistency of the food items. Solids, generally, had a higher caloric intensity and a larger estimation error than liquids, resulting in a greater difference between actual and estimated amount of calories for solids than for liquids. Furthermore, the amount of calories in solids were overestimations of actual consumption and underestimations for liquids.

Due to the very complex nature of the design of the experiment, there are data from several sub-experiments not included in this report. These data include the add and delete forms and test items determined prior to the beginning of the experiment, the food quality survey and debriefing questions at the end of the nine days, and the protocol of food related conversation by the four Increwmen. Analysis of these data was not included in the Contract under which this report was developed.

List of Figures


Fig. 1 Day-to-day variations in caloric intake during isolation. The values shown are deviations from the mean caloric intake averaged over the entire eight days. 18

Fig. 2 Temporal pattern of food consumption for one of the Increwmen. Consumption is shown as a cumulative record across nine days of isolation. 21

Fig. 3 Temporal pattern of food consumption for Outcrewmember No. 1. Consumption is shown as a cumulative record across nine days of isolation, but the ninth day does not include the evening meal. 22

Fig. 4 Temporal pattern of food consumption for Outcrewmember No. 3. Consumption is shown as a cumulative record across nine days of isolation, but the ninth day does not include the evening meal. 23

Fig. 5 Correlation scatter diagram for probability of food item selection as related to the Hedonic Preference value of that item for one crewmember. The large number of zero probability items numerically reduces the correlation coefficient. 40

Fig. 6 Correlation scatter diagram for the probability of food item selection as related to the Preferred Frequency of that item. 41

Fig. 7 Percentage of total calories in each food group. 50

Fig. 8 Comparison of Gross Percentage of the Difference for amounts and calorated amounts. 65

List of Tables


Table 1 - Weight and Caloric Intake of Individual Crew members during the Experiment 16

Table 2 - Average Daily Caloric Intake as Distributed Among Meals and Snacks 19

Table 3 - Percent of Individual's Daily Caloric Intake as a Function of Meals and Snacks 20

Table 4 - Breakfast - Food Consumption as a Function of Food Class 25-26

Table 5 - Lunch - Food Consumption as a Function of Food Class 27-28

Table 6 - Dinner - Food Consumption as a Function of Food Class 29-30

Table 7 - Probability that at Least One Item of a Class was Selected by the Average Crewmember at a Meal 32-33

Table 8 - Food Classes with the Highest Probability of Having an Item Selected for a Meal 34

Table 9 - Food Items Often Chosen More than once by an Individual as Part of a Meal 35

Table 10 - Individual Mean Hedonic Preference and Preferred Frequency Scores from the Pre-Experiment Survey 37

Table 11 - Food Preference Survey - Mean Hedonic Preference and Preferred Frequency Scores 38

Table 12 - Correlations Between Hedonic Preference and Preferred Frequency Scores and Overall Probability of Item Selection 42

Table 13 - Correlation Between Preferred Frequency Scores and Probability of Selection for Individuals 44

Table 14 - Correlations Between Hedonic Preference and Preferred Frequency Scores as a Function of Food Class 45-46

Table 15 - Food Groups and the Classes Within Each Group 49

Table 16 - Gross Number of Servings (Actual and Recorded) and the Gross Percentage of the Difference for the Diary Data 51

Table 17 - Gross Percentage of the Difference for the "Revised Diary" 53

Table 18 - Algebraic and Arithmetic Sum of Misrecordings 54

Table 19 - Algebraic and Arithmetic Average Proportion of Misrecordings 55

Table 20 - Gross Amount Consumed in Grams (Actual and Recorded) 57

Table 21 - Gross Percentage of the Difference in Amount (Diary and Revised Diary) 58

Table 22 - Algebraic and Arithmetic Sum of Estimation Error 60

Table 23 - Algebraic and Arithmetic Average Proportion of Estimation Error 61

Table 24 - Gross Calorated Amounts (Actual and Recorded) 64

Table 25 - Average Ratios of Error for Total Food Items 67

# FOOD PREFERENCE, ACCEPTANCE AND CONSUMPTION IN A SIMULATED, ISOLATED-DUTY STATION

## INTRODUCTION

Isolated, small-crew, duty stations must provide a complete living environment for their inhabitants. The inhabitants are generally most productive when the isolated environment provides for a lifestyle very similar to the individuals' previous experience. Optimally, the isolated duty station would provide the full range of activities and choices available in ordinary life settings. Unfortunately, the logistic difficulties created by the remoteness of such stations dictate severe restrictions of the optimum living environment. These restrictions are most noticeable as reductions in the freedom of immediate choice by the inhabitants. While an acceptable spectrum of activities and provisions is included in most isolated stations, their use is rigidly preplanned and scheduled. The extent and rigidity of this preprogramming is the result of limited storage space and the difficulty or impossibility of replenishment from the outside. The effect of the extensive preprogramming is the curtailment of spontaneous choices by the inhabitants and the difficulty of compensating, on the spot, for deficiencies and errors in the preplanning. As a consequence, the process of preplanning is critical, and any information which will facilitate effective planning is significant.

The effect and importance of the process of preplanning is more obvious with regard to food than it is for any other aspect of the isolation environment. Factors which increase the difficulty of food related preplanning include the fact that much of it is perishable, menu planning is complex in that it involves several items at a time, individual preferences are very strong, good nutrition must be maintained, and the fact that isolation station inhabitants regard "good" meals as perhaps the most significant element of successful habitation.

This experiment, in the setting of a simulation of an isolated, small-crew, duty station, was directed toward obtaining information relevant to food planning. There were two primary goals. The first was to assess the effects of isolation on various food behaviors, including amount and pattern of food consumption, and patterns of choice and selection as related to stated preferences. The second goal was the evaluation of some procedures for gathering food related data from crewmembers. These included food hedonic preference and preferred frequency rating scales, and the food consumption diary.

## EXPERIMENTAL DESIGN

The experiment was conducted in a university laboratory designed to functionally simulate an isolated small crew duty station. It provided a self-contained or closed living environment for twelve people, with about seven square meters of space for each person. The laboratory was divided into two separate but adjoining areas, each containing several rooms, and each self-contained with a bath and facilities for leisure, sleeping and work. The smaller area, Inner Space, was adequate for four crewmen, and contained Closed Circuit Television cameras and microphones, but included no food storage or preparation facilities. The larger area, Outer Space, was the control and observation center, and contained food preparation facilities for the entire crew of twelve. The experiment which was run during August, 1974, was nine continuous days in duration, with none of the crewmembers leaving the laboratory during that period. The most significant differences between the simulation and an actual isolated station were the virtual absence of physical stress and danger, and the inclusion of the food experiments.

Of the total of twelve crewmembers, four were a select crew, the Inner Crew, inhabiting the smaller Inner Space and thus separated for the duration from the eight members of the Outer Crew. The Inner Crew, unaware that the primary purpose of the experiment was the study of food behavior, worked about eight hours per day to complete a college course for credit and a grade. The eight Outer crewmembers constantly monitored the activities of the Increwmen and prepared the food and maintained food related data collection for all 12 crewmembers.

Each of the 12 completed a food hedonic preference and preferred frequency rating scale, before, during and at the end of the experiment, and each kept a daily 24-hour diary of food consumption during the experiment. Each crewmember selected all food from one of three large lists, a snack list with 40 items, a breakfast list with 25 items, and a lunch-dinner list with 126 items. Each individual item was weighed as served, as was any unconsumed remainder.

The design thus provided for the examination of the following:

- The temporal pattern, within and across days, of food consumption.
- The temporal pattern, across days, of choice of types of food.

- o Changes of expressed food hedonic preferences, as measured by the rating scales, during habitation.
- o The relationship between hedonic preference, as measured by the rating scales, and actual food choice.
- o The relationship between expressed food hedonic preference and the amount consumed.
- o The accuracy of reporting on the food diary the specific items actually consumed.
- o The accuracy of reporting on the food diary the amounts actually consumed.

## METHOD

SUBJECTS. The total group of 12 subjects was composed of two unique subgroups, the Increw, a select group of four, and the Outcrew, a group of eight laboratory staff members.

The Increw were four male university students between the ages of 23 and 25. Of the pool of prospective subjects available, the four selected had mean hedonic preference scores most nearly approximating an Air Force mean food hedonic preference score. These scores were derived from ten of the foods on a 220-item food Preference Survey administered three weeks before the experiment. Each was in apparently excellent physical health and was within the normal weight range for his age and height. They were in apparently good mental health, and scored within normal ranges on the Minnesota Multiphasic Personality Inventory. Each had previous military service, one having served a tour in an isolated duty station. Each also had an expressed need for credit for a statistics course.

During extensive interviews and briefing sessions, the nature of the simulation, its duration, requirements and hazards, were fully explained to the Increwmen. The explanations stressed the idea that a primary goal of the experiment was to study and record their use or consumption of all the features and provisions of the habitat, including leisure provisions such as music, books and magazines, and living provisions such as hygiene materials and food. Throughout the experiments all the food related procedures had apparent counterparts relating to other types of consumables. Daily consumption diaries, for example, were kept for music, reading and TV as well as for food. The special emphasis on food was not revealed to the Increw until the post experi-

ment debriefing, at which time all four, even when questioned about the purpose of the experiment, stated that they had been unaware of any unique emphasis on food.

Each of the Increwmen was paid $250.00 for participation, and successfully completed the statistics course for credit and a grade.

The eight members of the Outcrew included the Principal Investigator and seven undergraduate student assistants, all experienced in the design and execution of isolation studies. Since they participated in the set-up of the experiment, all were aware of the special emphasis on food procedures and data. The age of the P.I. was 41, the students between 21 and 31, and all body weights, shown in Table 1, were within normal ranges. Three of the Outcrew were females. All food related measures, procedures and data pertaining to the Increw were also applied to the Outcrew, who also prepared and weighed food for the entire crew. For participating in isolation, the students were paid $250.00 in addition to their regular pay as staff members.

In addition to the twelve isolated crewmembers, there were other "non-isolated" personnel involved in the execution of the experiment. There were three student assistants whose task was to bring provisions and supplies, as needed during the experiment, to the door of the laboratory. Two members of the professional staff of the Natick Research and Development Command also participated extensively in the planning and execution of the experiment. At least one of them was working with the Outcrew during the entire experiment.

FACILITIES, INSTRUMENTS AND PROVISIONS. The laboratory included a large control and observation room immediately adjoining, but acoustically and visually separated from the inner confinement area. (See Appendix F for the plan of the isolation laboratory.) The control room (120 $m^2$) included a fully equipped kitchen, and an observation and data area, adequate hygiene facilities and an adjoining leisure-living area.

The inner confinement space included: (a) a work room (9 $m^2$), containing a large table and secretary's chairs, book shelves, calculators, reference and work material for the statistics course, and music speakers; (b) two general purpose rooms (9 $m^2$), each containing a TV set, high quality stereo system, large and small chairs, and drapes and carpet; (c) a bathroom (2.5 $m^2$), with shower, sink, small toilet, cabinet and shelves with linens and toiletry supplies; and (d) a hallway

(9 $m^2$) with additional storage shelves. The wall between the Inner Space and the Control Room contained an interlock for delivery of food, exchange of small items, and garbage ejection without exposure to the Control Room. An intercom system provided communication between each of the Inner areas and the Control Room. Closed Circuit Television cameras and multiple microphones provided for continuous monitoring of Increw activities in all areas except the bathroom. Dim lights remained on at all times.

Control of temperature, lights, water, music, TV, etc., were directly accessible to the Increw. Leisure provisions were located within Inner space, and included the following:

Music: More than 1000 taped records distributed among all the major categories such as classical, folk, rock, show tunes, etc.

Books: Approximately 500 books distributed among categories such as fiction, poetry, best sellers, hobby books, philosophy, etc.

Magazines: A variety of current men's magazines, technical and business magazines, comics, etc.

Games, Hobbies, and Crafts: Included group and solitary games, cards, wood carving, painting, fiber optics, puzzles, etc.

Television: Included three local stations in black and white.

Work materials provided for each Increwman consisted of a set of volumes entitled "Psychological Statistics" (published by Individual Learning Systems), a calculator, a spiral notebook, graph paper, and pencils. Also available were various additional statistics texts and a reference list to guide the Increwmen to other material and exercises. A unit test was provided for each unit in the programmed sequence and a comprehensive final exam was given on the last day of the experiment.

The kitchen, located in the Control room area, was approximately 3.5 m x 3.5 m, with one side open to the Control room. Equipment included a stove, oven, sink, three refrigerators, shelving and counters, a microwave oven, and a Mettler P 1200 top loading scale. All food was served on disposable containers of lightweight plasticware manufactured by Sweetheart Paper Company, Inc.

There were 158 food items available, all taken from the Armed Forces 42-Day Master Menu. Most entrees were obtained, as needed, freshly prepared from "franchise type" restaurants in the area. Entrees

not available from area restaurants and all other foods such as breakfasts, vegetables, salads and snacks were prepared in the kitchen from "name brand" canned or frozen packages. Fresh fruits, vegetables and eggs were obtained from the local "farmers' market".

There were three types of menu/order forms, one each for breakfast, lunch/dinner, and snacks. Identical menu/order forms were available for all crewmembers for all days of the experiment. Each form provided space for the crewmember's name and the date and time. Each item available on that menu/order form was printed with space for the crewmember to indicate which items were desired, how many units of those items, and how they were to be prepared, (well done, over light, etc.). Space was provided beside each item for recording the weight of the container, the gross weight when served, the gross weight when returned and the weight of edible waste returned. Appendix A details, for each of the 158 items, the menu/order forms on which it was available, the total number of times it was actually served, and the average weight, in grams, of the servings of that item.

The consumption diaries were mimeographed forms divided into separate segments for food, music, reading, and TV. Each diary form covered a 24 hour day and was subdivided into four quadrants of the day, with quadrants beginning at 0300 hours, 0900 hours, 1500 hours and 2100 hours, respectively. These hours insured that, at least for Increwmen, meals fell within, rather than on, the boundaries of a quadrant. The diary form included four pages, one for each quadrant. The food portion of the diary contained space for recording the various items consumed during the four quadrants of the previous day, the number of units of that item consumed, and the estimated weight of the items consumed in ounces. (One of the Inner crewmen was, at his request, permitted to record estimates in grams.) The printed instructions for the diary are included as Appendix B.

The Preference Survey form included sections for food, music, reading, and TV, all in a similar format. The food part of the Survey form included 220 items, drawn primarily from the Armed Forces 42-Day Master Menu, including all of the 158 items available in the experiment. The items included on the form but not available in the experiment are listed in Appendix C. The form provided for rating each item on two different scales, a nine-point hedonic preference scale and a preferred frequency scale. The hedonic preference scale ranged from 1 (dislike

extremely) to 9 (like extremely). The preferred frequency scale provided for a judgement (from 0 to 30) of the number of days per month that item was desired. Space was also provided for indicating that an item had never been tried.

PROCEDURE AND SCHEDULES. Three weeks before the experiment all twelve crewmembers completed the Preference Survey form for the first time and received their first extensive briefing about the schedule and procedures during the experiment. One week before the experiment each of the twelve, except the P.I. received a "tentative" menu drawn from the results of the initial Preference Survey. The food part of this menu omitted fifty items of high, medium, and low average hedonic preference values, and contained ten items of extremely low average hedonic preference value. Each of the eleven crewmembers was asked to list items they desired to have added to the menu and items they felt could be dropped. The final 158 item menu was then prepared by adding a previously selected high mean hedonic preference subset of ten of the omitted 50 items whether or not any crewmember suggested them, and any other item from the 220 item Preference Survey List which any crewmember suggested. Items suggested for dropping were left on the menu to determine whether they would, in fact, be chosen. Analogous procedures were also used for music and reading, in order to avoid calling the attention of Increwmen to the special importance of food in this experiment.

During the evening prior to the formal start of the experiment there were additional extensive briefings and instructions for all crewmembers, and Informed Consent Forms were signed by all. Following the signing of the forms, the crews were separated, the door between the two areas and the door to the outside were formally closed for the duration. The doors were never physically locked, permitting rapid egress in the case of an emergency. During the remainder of the evening all procedures to be used throughout the experiment were put into effect, providing enough practice to permit them to run smoothly when the experiment formally began the next morning.

The daily schedules and types of activities during the experiment were somewhat different for the Increw and Outcrew. The work task for the Increw was the statistics course, which required approximately eight hours per day, and their schedule was formal and regular, whereas the Outcrew was performing the diverse variety of work associated with running the experiment, preparing and handling all the food and maintain-

ing continuous observation of the Increw. As a result, the daily schedule of the Outcrewmembers was much less regular. Work shifts began as early as 5:30 A.M. and ended as late as 1:00 A.M., with at least one person required for the all-night shift each day.

The daily schedule for the four Increwmen was built around a required 9 to 5 workday with a 30-minute lunch break. Their meal availability periods were 0700 to 0900, 1130 to 1300, and 0730 to 0900, with snacks, including beverages, available anytime, day or night. The workday began at 0900, with the task of filling out the daily Consumption Diary form, recording on it all items consumed during the 24 hours preceding 0300 that day. On the fourth day this requirement also included completing a Preference Survey Form, and on the ninth day, both a Preference Survey Form and a Food Quality Form. Use of leisure facilities and provisions was not permitted during working hours, except during the lunch break. Each crewman was required to record his body weight before breakfast.

For members of the Outcrew considerably more flexibility of schedule was required, since work schedules began at different hours on different days for each crewman. In general, breakfast was available within the first two hours after awakening, before 1230. Lunch and dinner windows were then set at approximately four and eight hours after breakfast, except that no dinner was served after 1130. Outcrew members were expected to weigh themselves soon after awakening, and to complete Consumption Diary forms within two hours, or as soon thereafter as their work schedule permitted.

All crewmembers ordered their food and snacks via the printed menu/order forms. All items desired at that time were checked on the appropriate form which was relayed to the Outcrewmember in charge of orders. Snack orders were filled immediately, while breakfast orders were required to be placed at least 30 minutes before serving, and lunch/dinner orders at least 90 minutes early. If a meal order required a restaurant entree, the order was called to the appropriate restaurant, and one of the non-crew personnel stationed outside the laboratory was sent to get it. All the items on each order were served in individual containers on a single tray. Serving sizes were deliberately varied approximately 50% around a "normal" serving size, in order to reduce the predictability which might otherwise influence size estimates in the food Consumption Diaries. Each item was weighed before serving by an Outcrewmember, but no member weighed his own food. For every

item the container weight and gross weight of item and container was recorded on the menu/order form. After reheating in the microwave if necessary, the order was delivered to the requesting crewman. The individual was expected to eat as soon as served, without removing foods from the tray, or sharing any food, and to return the tray as soon as the meal or snack was completed. Upon return, the gross weight of each remainder and container was recorded, any edible remainder was removed, and the gross weight of the inedible waste and container was recorded. (The edible remainder was consistently determined via operational procedures defined prior to the experiment.) This procedure provided for determining the exact amount of every food item consumed by each crewmember.

Beginning and ending times were also recorded for each individual's meal. Comments were solicited regarding any item which was largely uneaten, and a comprehensive log was kept of all food related conversational comments among the Increwmen throughout the experiment.

During the last day of the experiment each Outcrewmember underwent a debriefing interview, as did each Increwman on the evening of the same day. The interview included questions about major discrepancies between successive Preference Survey forms, about food changes that might be desirable for longer experiments, about the most pleasant and unpleasant eating experiences, about the extent to which their food behavior during the experiment differed from their usual food behavior, and about the desirability of more limited menus which changed from day to day, as compared to the large but constant menu used in this experiment.

## RESULTS

### FOOD CONSUMPTION

On the average, the rate of food consumption during the experiment exceeded 3000 calories per day. As shown in Table 1 the grand average daily rate was 50 cal/kg. As a point of comparison, the average daily pre-mission intake for the crews of Apollo 9, 12, 16 and 17 was 37 cal/kg, and this decreased to 27 cal/kg during the mission. As may be seen in Table 1, the high food consumption rate in the present experiment led to an average weight gain of 1 kg, or 1.5%, during the experiment. The Outcrew, whose level of activity was considerably greater,

Table 1

Weight and Caloric Intake of Individual Crewmembers during the Experiment

| | | | During First Eight Days | | |
|---|---|---|---|---|---|
| Crewmember | Sex | Mean Weight | Weight Change | Calories Per Day | cal/kg Per Day |
| Inner 1 | M | 73.5 | +1.4 | 3191 | 43 |
| Inner 2 | M | 60.3 | +1.4 | 3123 | 52 |
| Inner 3 | M | 70.3 | +1.4 | 3580 | 51 |
| Inner 4 | M | 74.8 | -0.9 | 3094 | 41 |
| Inner Avg | | 69.7 | +1.3 | 3247 | 47 |
| Outer 1 | M | 75.8 | 0.0 | 3631 | 48 |
| Outer 2 | M | 72.1 | +2.3 | 3850 | 53 |
| Outer 3 | F | 49.4 | +0.7 | 2302 | 47 |
| Outer 4 | F | 48.1 | 0.0 | 3188 | 66 |
| Outer 5 | F | 52.2 | +1.8 | 2949 | 57 |
| Outer 6 | M | 60.8 | +2.3 | 3697 | 61 |
| Outer 7 | M | 75.3 | 0.0 | 3593 | 48 |
| Outer 8 (PI) | M | 65.3 | 0.0 | 2781 | 43 |
| Outer Avg | | 62.3 | +0.9 | 3249 | 52 |
| Grand Avg | | 64.8 | +1.0 | 3248 | 50 |

also had a higher average rate of caloric intake with a smaller average weight gain than the four Increwmen.

That there was considerable day-to-day variation in the caloric intake for individuals can be seen from the curves for the four individual Increwmen in Figure 1. The variation was even greater for the Outcrew, whose work/sleep schedules, unlike the regimented schedules of the Increw, varied greatly from day to day. As seen in the grand mean curve, there was a general tendency to eat more than average during the first day, and all but one of the twelve ate less than their daily average mean on the eighth day. Although there were large individual differences in the day-to-day pattern, the composite grand mean curve suggests a cyclic pattern overall. The downward trend on the eighth day appears to have continued on the ninth day, which is not presented because complete data were not obtained on that day. Though the form of this general consumption cycle may generalize to other ten-day experiences, it is probably not safe to generalize it to habitation of different durations. Data from previous experiments in this laboratory suggest a strong influence of the beginning and ending days on the pattern of consumption of both food and nonfood resources. It is not impossible that the sharp decline toward the end was partially the result of the gain in weight, which was emphasized by the fact that each crewmember recorded his weight daily.

On the average, both crews consumed about 35% of their total daily calories at dinner, and about 20% at breakfast. As seen in Table 2, however, there was a very large difference between the crews in the distribution of the remaining 45% of calories. The Increw, living by a regular schedule, took 30% of their calories as lunch, and only 16% as snacks. The pattern was exactly reversed, 16% lunch and 30% snacks, for the Outcrew. This reversal probably is due to the unique schedule of the Outcrew, who, on days when their work schedule began late, tended to eat a late breakfast and skip lunch altogether, compensating with an increase in snacks.

As seen in Table 3, there was considerable day-to-day variation in the distribution of calories among meals. For individual crewmembers the effect is even greater, as illustrated in Figure 2, Figure 3 and Figure 4. These figures present cumulate curves of caloric intake as a function of time of day, for each day of the experiment. Figure 2 depicts the consumption pattern of Increwman #3. His pattern was typical of all the Increwmen. Figure 3 is for Outcrewmember #1, who had the least regular

Fig. 1

Day-to-day variations in caloric intake during isolation. The values shown are deviations from the mean caloric intake averaged over the entire eight days

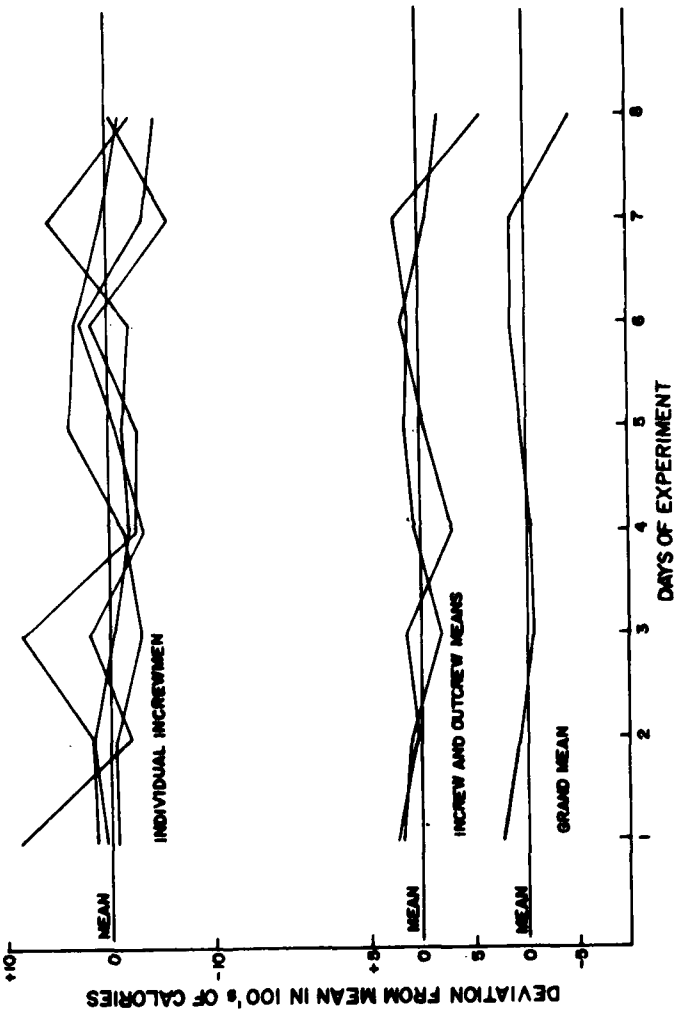


Table 2

Average Daily Caloric Intake
as Distributed Among Meals and Snacks

| | Inner 4 | Outer 8 | Total 12 |
|---|---|---|---|
| Breakfast | 18.6% | 20.2% | 19.6% |
| Lunch | 30.4% | 16.2% | 21.1% |
| Dinner | 34.7% | 34.6% | 34.7% |
| Snacks | 16.3% | 28.9% | 24.7% |

Table 3

Percent of Individual's Daily Caloric Intake as a Function of Meals and Snacks

| | Day of Experiment | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Inner 4 | | | | | | | | |
| Breakfast | 18 | 16 | 16 | 18 | 21 | 24 | 15 | 20 |
| Lunch | 38 | 33 | 26 | 29 | 26 | 28 | 31 | 32 |
| Dinner | 29 | 37 | 38 | 31 | 37 | 32 | 39 | 35 |
| Snacks | 15 | 14 | 20 | 21 | 16 | 16 | 15 | 13 |
| Outer 8 | | | | | | | | |
| Breakfast | 26 | 22 | 22 | 25 | 19 | 12 | 22 | 12 |
| Lunch | 6 | 20 | 21 | 11 | 23 | 16 | 17 | 20 |
| Dinner | 36 | 32 | 31 | 37 | 36 | 36 | 30 | 41 |
| Snacks | 33 | 26 | 26 | 27 | 23 | 36 | 32 | 27 |
| Total 12 | | | | | | | | |
| Breakfast | 23 | 20 | 20 | 23 | 20 | 16 | 20 | 15 |
| Lunch | 16 | 24 | 23 | 17 | 24 | 20 | 21 | 24 |
| Dinner | 33 | 34 | 34 | 35 | 36 | 35 | 32 | 39 |
| Snacks | 27 | 22 | 24 | 25 | 21 | 29 | 26 | 22 |

Fig. 2

Temporal pattern of food consumption for one of the Increwmen.
Consumption is shown as a cumulative record across nine days of isolation.

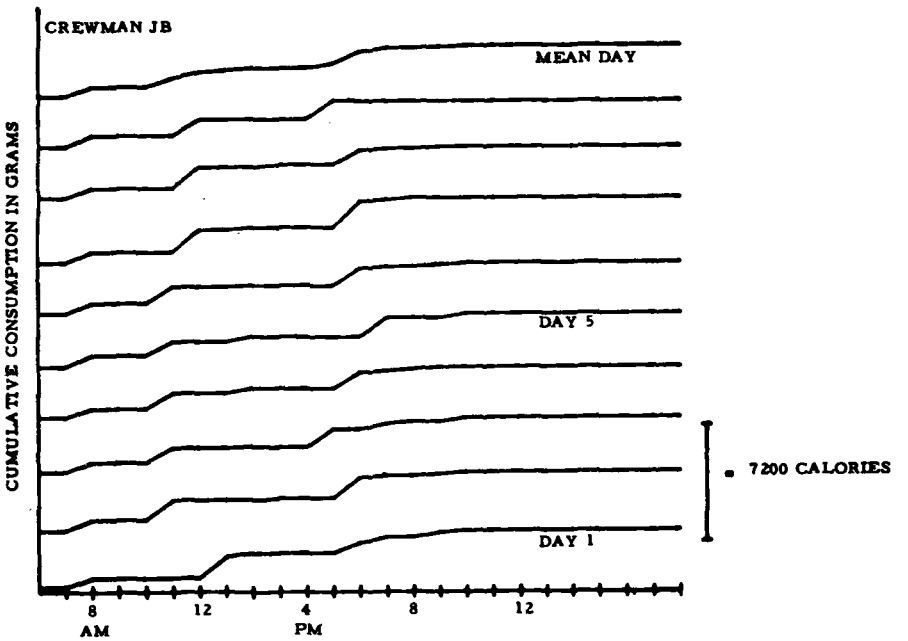


Fig. 3

Temporal pattern of food consumption for Outcrewmember #1. Consumption is shown as a cumulative record across nine days of isolation, but the ninth day does not include the evening meal

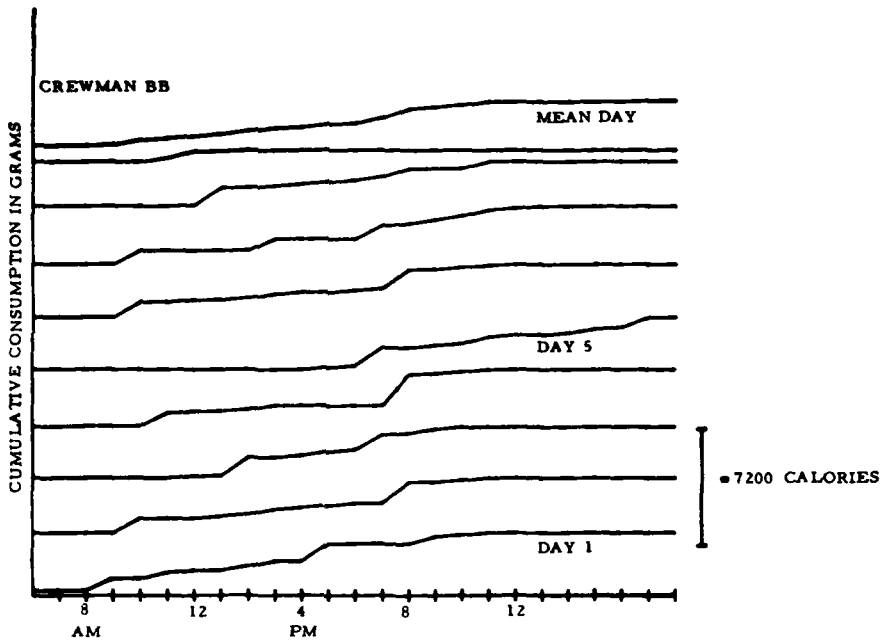
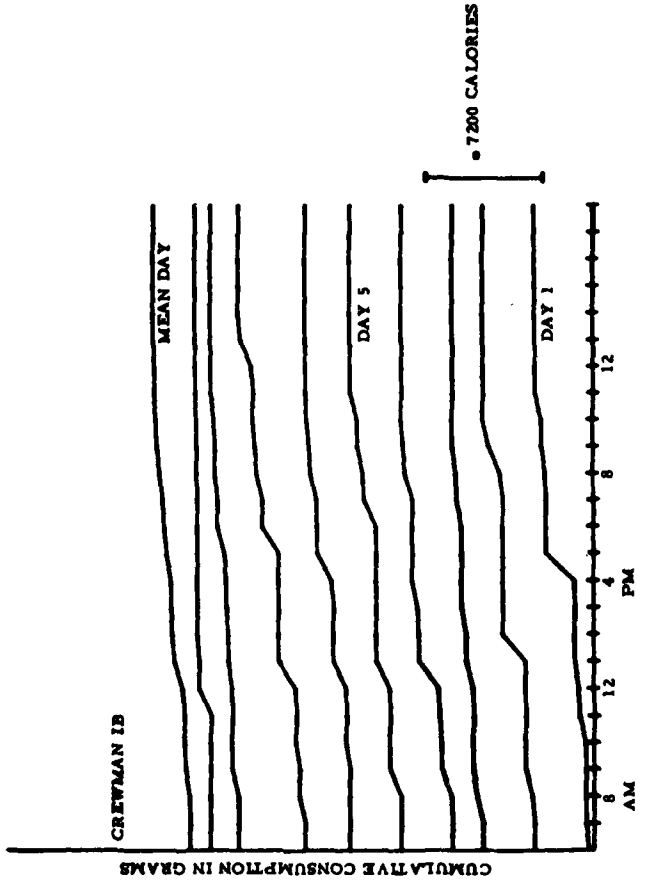


Fig. 4

Temporal pattern of food consumption for Outcrewmember #3. Consumption is shown as a cumulative record across nine days of isolation, but the ninth day does not include the evening meal



pattern of consumption, while a pattern relatively typical for the Outcrew is seen in Figure 4, (Outcrewmember #3). Generally the variability was much greater for Outcrewmembers.

In general, there does not appear to be any consistent trend, over days of inhabitation, toward a systematic change in the allocation of caloric intake among meals and snacks. The variations from day-to-day are large, particularly for the Outcrew, but the variation between individuals is also large enough to mask any systematic trends.

Food consumption as a function of food classes is shown in Tables 4-6. Each of these tables, one each for breakfast, lunch and dinner, indicates the average amount, in both grams and calories consumed by a crewmember from each food class. The Inner 4 and Outer 8 were remarkably similar for both breakfast and dinner, with some difference apparent for lunch. At breakfast Outcrewmembers consumed less fruit juice and hot beverage, which were in fact frequently obtained as snacks before breakfast was served. Outcrewmembers also ate some grits (Class 16) while Increwmen did not. At dinner, Outcrewmembers consumed less milk and more beer than Increwmen, and consumed more meat from the extended meats class than did Increwmen. Both crews tended to eat a relatively typical meat and vegetables dinner. At lunch, the distributions for In and Out crewmembers are similar except for sandwiches and colas. This is again consistent with the tendency of the erratically scheduled Outcrew, to omit, or at least minimize lunch on the days when they ate a late breakfast, whereas Increwmen tended to eat a relatively stereotyped sandwich and cola lunch. In general, then, the food class composition of the various meals appears quite similar for the two crews.

Inspection of daily meal by class distributions revealed large day-to-day variations, but no trace of any consistent trend over days toward a change in the distribution of consumption among food classes.

Examination of calorie figures in Tables 4-6 reveals that caloric intake at breakfast was largely drawn from eggs, pancakes and waffles; and biscuits, toast and donuts. At lunch the greatest caloric input is drawn from sandwiches and short orders, and colas. At dinner, caloric intake is greatest for meats, desserts and hot breads.

Table 4

Breakfast

Food Consumption as a Function of Food Class

| Food Class | Grams | | | Calories | | |
|---|---|---|---|---|---|---|
| | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
| 01 Soups | | | | | | |
| 02 Juices, Fruit and Vegetable | 183 | 127 | 146 | 82 | 52 | 62 |
| 03 Drinks, Iced Coffee, Iced Tea | | | | | | |
| 04 Hot Beverages | 99 | 57 | 71 | 1 | 7 | 5 |
| 05 Milk Products | 104 | 113 | 110 | 69 | 74 | 72 |
| 06 Beverages, Carbonated | | | | | | |
| 07 Beer | | | | | | |
| 08 Hot Breads, Donuts | 37 | 34 | 35 | 135 | 125 | 129 |
| 09 Breakfast Cereals, Griddle | 27 | 45 | 39 | 69 | 169 | 136 |
| 10 Eggs | 73 | 75 | 74 | 141 | 145 | 144 |
| 11 Breakfast Meats | 23 | 14 | 17 | 97 | 58 | 71 |
| 12 Fish and Seafoods | | | | | | |
| 13 Meats | | | | | | |
| 14 Stews & Extended Meats | | | | | | |
| 15 Short Orders, Sandwiches | | | | | | |

Table 4 (Continued)

Breakfast

Food Consumption as a Function of Food Class

| Food Class | Grams | | | Calories | | |
|---|---|---|---|---|---|---|
| | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
| 16 Potato and Potato Substitutes | | 14 | 9 | | 7 | 5 |
| 17 Green Vegetables | | | | | | |
| 18 Yellow and other Vegetables | | | | | | |
| 19 Salads, Vegetable and Green | | | | | | |
| 20 Salad Dressing | | | | | | |
| 21 Fruit | 21 | 29 | 27 | 9 | 17 | 15 |
| 22 Cookies, Brownies, Cakes | | | | | | |
| 23 Pies | | | | | | |
| 24 Ice Cream, Pudding | | | | | | |
| 25 Snacks, Candy | | | | | | |

Table 5

Lunch

Food Consumption as a Function of Food Class

| Food Class | | Grams | | | Calories | | |
|---|---|---|---|---|---|---|---|
| | | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
| 01 | Soups | 9 | 8 | 8 | 6 | 6 | 6 |
| 02 | Juices, Fruit and Vegetable | | 9 | 6 | | 2 | 2 |
| 03 | Drinks, Iced Coffee, Iced Tea | 58 | 40 | 46 | 1 | 1 | 1 |
| 04 | Hot Beverages | 22 | 7 | 12 | 0 | 0 | 0 |
| 05 | Milk Products | 42 | 68 | 59 | 28 | 45 | 39 |
| 06 | Beverages, Carbonated | 191 | 52 | 98 | 74 | 21 | 39 |
| 07 | Beer | | 30 | 20 | | 13 | 8 |
| 08 | Hot Breads, Donuts | 12 | 7 | 9 | 37 | 20 | 26 |
| 09 | Breakfast Cereals, Griddle | | | | | | |
| 10 | Eggs | | | | | | |
| 11 | Breakfast Meats | | | | | | |
| 12 | Fish and Seafoods | 8 | | 3 | 18 | | 6 |
| 13 | Meats | 21 | 6 | 11 | 63 | 12 | 29 |
| 14 | Stews & Extended Meats | 27 | 47 | 41 | 36 | 68 | 58 |
| 15 | Short Orders, Sandwiches | 158 | 61 | 93 | 419 | 167 | 251 |

Table 5 (Continued)

Lunch

Food Consumption as a Function of Food Class

| Food Class | Grams | | | Calories | | |
|---|---|---|---|---|---|---|
| | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
| 16 Potato and Potato Substitutes | 23 | 13 | 16 | 60 | 28 | 39 |
| 17 Green Vegetables | 3 | 2 | 2 | 1 | 1 | 1 |
| 18 Yellow and other Vegetables | 24 | 8 | 13 | 21 | 8 | 13 |
| 19 Salads, Vegetable and Green | 35 | 38 | 37 | 10 | 15 | 13 |
| 20 Salad Dressing | 9 | 7 | 8 | 48 | 33 | 38 |
| 21 Fruit | | 2 | 2 | | 1 | 1 |
| 22 Cookies, Brownies, Cakes | 7 | 18 | 15 | 24 | 47 | 40 |
| 23 Pies | 25 | 7 | 13 | 65 | 21 | 35 |
| 24 Ice Cream, Pudding | 44 | 14 | 24 | 77 | 25 | 42 |
| 25 Snacks, Candy | | | | | | |

Table 6

Dinner

Food Consumption as a Function of Food Class

| Food Class | | Grams | | | Calories | | |
|---|---|---|---|---|---|---|---|
| | | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
| 01 | Soups | | 16 | 11 | | 13 | 8 |
| 02 | Juices, Fruit and Vegetable | | 12 | 8 | | 3 | 2 |
| 03 | Drinks, Iced Coffee, Iced Tea | 117 | 164 | 148 | 2 | 3 | 3 |
| 04 | Hot Beverages | 39 | 2 | 15 | 0 | 0 | 0 |
| 05 | Milk Products | 133 | 66 | 88 | 88 | 43 | 58 |
| 06 | Beverages, Carbonated | 37 | 32 | 33 | 14 | 13 | 13 |
| 07 | Beer | 11 | 65 | 47 | 5 | 27 | 20 |
| 08 | Hot Breads, Donuts | 32 | 36 | 35 | 97 | 107 | 103 |
| 09 | Breakfast Cereals, Griddle | | | | | | |
| 10 | Eggs | | | | | | |
| 11 | Breakfast Meats | | | | | | |
| 12 | Fish and Seafoods | 39 | 27 | 31 | 87 | 60 | 69 |
| 13 | Meats | 104 | 72 | 82 | 294 | 202 | 233 |
| 14 | Stews & Extended Meats | 25 | 66 | 53 | 32 | 108 | 83 |
| 15 | Short Orders, Sandwiches | 10 | 7 | 8 | 24 | 18 | 20 |

Table 6 (Continued)

Dinner

Food Consumption as a Function of Food Class

| Food Class | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
|---|---|---|---|---|---|---|
| 16 Potato and Potato Substitutes | 72 | 60 | 64 | 80 | 67 | 71 |
| 17 Green Vegetables | 45 | 27 | 33 | 21 | 15 | 17 |
| 18 Yellow and other Vegetables | 41 | 35 | 37 | 28 | 31 | 30 |
| 19 Salads, Vegetable and Green | 54 | 68 | 66 | 13 | 15 | 14 |
| 20 Salad Dressing | 12 | 15 | 14 | 60 | 73 | 31 |
| 21 Fruit | 7 | 58 | 41 | 7 | 31 | 23 |
| 22 Cookies, Brownies, Cakes | 48 | 60 | 56 | 134 | 151 | 145 |
| 23 Pies | 39 | 31 | 34 | 105 | 89 | 94 |
| 24 Ice Cream, Pudding | 23 | 29 | 27 | 38 | 57 | 51 |
| 25 Snacks, Candy | | | | | | |

FOOD CONSUMPTION: SUMMARY. Overall caloric intake was higher than expected from available comparative data, with a consequent weight gain for many of the crewmembers. There was day-to-day variation of caloric intake for all crewmembers, but the only clear general trend was a decline in intake on the final two days. Increw-members, with a relatively normal schedule of activities, displayed a fairly common pattern of intake during a day, with about 19% of their calories obtained from breakfast, 30% from lunch, 35% from dinner and 16% from snacks. For Outcrewmembers, with irregular schedules, the proportion of calories obtained from lunch and snacks was switched: 16% from lunch and 30% from snacks, while proportions for breakfast and dinner were the same as for Increwmembers.

## FOOD CHOICE

In order to examine the patterns of food choice during the experiment, the actual selections of meal items were transformed into probability scores. These scores were derived by dividing the actual number of selections by the number of opportunities for selection of that item. Inspection of distributions of these scores by day and by crewmember revealed little difference from the analogous distributions for consumption. There was large variability among individuals and the means of all 12 crewmembers combined varied noticeably from day to day. There were no detectable systematic shifts in probability for either food classes or individual items as a function of the duration of the experiment. The general pattern of choice of meal items as a function of food classes was obtained by calculating the probability, for each class, that at least one item from that class was selected at each meal by the average crewmember. These figures are shown in Table 7, and represent the average of all 12 crewmembers. (Differences between the two crews with respect to the distribution of choice among classes are identical to the differences relating to distribution of consumption, discussed previously.) The classes which had the highest probability of selection for each meal are shown in Table 8. The fact that the probabilities are numerically higher for the breakfast selections is at least partially due to the fact that the individual breakfast items were contained in a smaller number of classes than were the items available for lunch and dinner.

Another dimension of choice behavior is the repeated selection of the same item. Table 9 lists those items which were chosen more than

Table 7

Probability That at Least One Item of a Class was Selected by the Average Crewmember at a Meal

| | | Breakfast | Lunch | Dinner |
|---|---|---|---|---|
| 01 | Soups | 0.00 | 0.05 | 0.04 |
| 02 | Juices, Fruit and Vegetable | 0.73 | 0.04 | 0.03 |
| 03 | Drinks, Iced Coffee, Iced Tea | 0.00 | 0.20 | 0.49 |
| 04 | Hot Beverages | 0.57 | 0.12 | 0.12 |
| 05 | Milk Products | 0.38 | 0.21 | 0.28 |
| 06 | Beverages, Carbonated | 0.00 | 0.46 | 0.10 |
| 07 | Beer | 0.00 | 0.07 | 0.12 |
| 08 | Hot Breads, Donuts | 0.74 | 0.17 | 0.61 |
| 09 | Breakfast Cereals, Griddle | 0.34 | 0.00 | 0.00 |
| 10 | Eggs | 0.58 | 0.00 | 0.00 |
| 11 | Breakfast Meats | 0.53 | 0.00 | 0.00 |
| 12 | Fish and Seafoods | 0.00 | 0.02 | 0.16 |
| 13 | Meats | 0.00 | 0.11 | 0.60 |
| 14 | Stews & Extended Meats | 0.00 | 0.21 | 0.17 |
| 15 | Short Orders, Sandwiches | 0.00 | 0.60 | 0.04 |

Table 7 (Continued)

Probability That at Least One Item of a Class was Selected
by the Average Crewmember at a Meal

| | | Breakfast | Lunch | Dinner |
|---|---|---|---|---|
| 16 | Potato and Potato Substitutes | 0.07 | 0.28 | 0.48 |
| 17 | Green Vegetables | 0.00 | 0.04 | 0.28 |
| 18 | Yellow and other Vegetables | 0.00 | 0.15 | 0.29 |
| 19 | Salads, Vegetable and Green | 0.00 | 0.30 | 0.53 |
| 20 | Salad Dressing | 0.00 | 0.25 | 0.46 |
| 21 | Fruit | 0.19 | 0.02 | 0.16 |
| 22 | Cookies, Brownies, Cakes | 0.00 | 0.15 | 0.25 |
| 23 | Pies | 0.00 | 0.11 | 0.26 |
| 24 | Ice Cream, Pudding | 0.00 | 0.23 | 0.19 |
| 25 | Snacks, Candy | 0.00 | 0.00 | 0.00 |

Table 8

Food Classes with the Highest Probability of Having an Item Selected for a Meal

| | P |
|---|---|
| BREAKFAST | |
| Hot Breads, Donuts | 0.74 |
| Juices, Fruit and Vegetable | 0.73 |
| Eggs | 0.58 |
| Hot Beverages | 0.57 |
| Breakfast Meats | 0.53 |
| LUNCH | |
| Short Orders, Sandwiches | 0.60 |
| Beverages, Carbonated | 0.46 |
| Salads, Vegetable & Green | 0.30 |
| Potato and Potato Substitutes | 0.28 |
| DINNER | |
| Hot Breads | 0.61 |
| Meats | 0.60 |
| Salads, Vegetable and Green | 0.53 |
| Drinks, Iced Tea | 0.49 |
| Potato and Potato Substitutes | 0.48 |

Table 9

Food Items Often Chosen More Than Once by an Individual as Part of a Meal

| Class No. | Class Name | Food Item | No. of Repeaters | Maximum No. Of Repetitions |
|---|---|---|---|---|
| 02 | Juices, Fruit and Vegetable | Orange Juice | 11 | 9 |
| 03 | Drinks, Iced Coffee, Iced Tea | Iced Tea | 9 | 10 |
| 04 | Hot Beverages | Hot Coffee | 7 | 10 |
| 05 | Milk Products | Milk | 9 | 10 |
| 06 | Beverages, Carbonated | Cola | 7 | 10 |
| 07 | Beer | Beer | 4 | 6 |
| 08 | Hot Breads, Donuts | Hot Rolls | 5 | 6 |
| | | French Bread | 7 | 7 |
| | | Biscuits | 5 | 6 |
| | | Buttered Toast | 9 | 9 |
| 09 | Breakfast Cereals, Griddle | Griddle Cakes | 4 | 3 |
| 10 | Eggs | Eggs to Order | 10 | 7 |
| 11 | Breakfast Meats | Breakfast Ham | 6 | 5 |
| | | Bacon | 6 | 7 |
| 12 | Fish and Seafoods | Fried Shrimp | 5 | 3 |
| 13 | Meats | Sirloin Steak | 5 | 3 |
| 15 | Short Orders, Sandwiches | Barbequed Pork Sandwich | 4 | 3 |
| 16 | Potato and Potato Substitutes | Baked Potato | 4 | 9 |
| 18 | Yellow and other Vegetables | Buttered Corn | 4 | 7 |
| 19 | Salads, Vegetable and Green | Tossed Green Salad | 10 | 10 |
| 21 | Fruit | Fresh Peaches | 4 | 4 |
| 22 | Cookies, Brownies, Cakes | Strawberry Shortcake | 4 | 5 |

once by at least 25% of the crew of 12. The number of individuals selecting an item twice or more is indicated, as is the largest number of repetitions by any crewmember. It may be noticed that this list includes items from the classes shown in Table 8 as having the highest probability of selection. This list does include one item each from three classes of lower probability; the corn from Yellow Vegetables, the peaches from Fresh Fruits, and strawberry shortcake from Cookies, Brownies and Cakes.

FOOD CHOICE: SUMMARY. There appeared to be no systematic shifts in probability of selection for either food classes or individual items as a function of the duration of the experiment. Selection of items for meals remained quite typical of normal meal composition, even among Outcrewmembers with irregular schedules. The items which were ordered more than once by at least 25% of the 12 crewmembers were also generally from food classes with highest overall probabilities of selection.

## FOOD PREFERENCE SURVEY

Analysis of the hedonic preference and preferred frequency scores from the Preference Survey completed before the experiment reveals, as shown in Table 10, variation in means and standard deviations among the individual crewmembers. The variation is smallest for the hedonic preference scores for the Inner 4, since these scores were part of the selection criteria for these four crewmen. Interestingly, however, the variation among preferred frequency scores (number of times an item is desired per month) is higher for that group. The overall correlation between hedonic preference and preferred frequency scores was 0.60, (0.64 for the Increw, and 0.58 for the Outcrew). The general pattern of scores was somewhat unusual for two of the Outcrew; Outcrewmember #2 rated almost every food as seven on the hedonic preference scale and ten days per month, and Outcrewmember #3 rated most foods as eight. Informal observations of their food behavior during the experiment indicated that this pattern actually did reflect their attitude toward food, they liked almost everything. Their general pattern of responding did not change appreciably on successive administrations of the survey form.

As can be seen in Table 11, there was a notable and consistent change in both hedonic preference and preferred frequency scores between the first and second administrations of the Survey, but little difference

Table 10

Individual Mean Hedonic Preference and Preferred Frequency Scores from the Pre-Experiment Survey

| Crewmember | Hedonic Preference | | Preferred Frequency | |
|---|---|---|---|---|
| | Mean | Sigma | Mean | Sigma |
| Inner 1 | 6.64 | 1.47 | 7.32 | 5.32 |
| Inner 2 | 6.39 | 1.45 | 14.32 | 11.87 |
| Inner 3 | 6.14 | 1.78 | 2.73 | 4.22 |
| Inner 4 | 6.90 | 1.05 | 7.66 | 4.24 |
| Inner Avg. | 6.52 | 1.44 | 8.01 | 6.41 |
| Outer 1 | 6.71 | 1.40 | 9.22 | 7.18 |
| Outer 2 | 6.85 | .91 | 10.00 | 3.82 |
| Outer 3 | 7.85 | .63 | 4.14 | 4.59 |
| Outer 4 | 6.58 | 1.60 | 7.41 | 8.58 |
| Outer 5 | 7.00 | 1.21 | 5.85 | 6.89 |
| Outer 6 | 6.33 | 2.20 | 4.89 | 5.73 |
| Outer 7 | 6.55 | 1.28 | 8.39 | 5.71 |
| Outer 8 | 5.86 | 2.33 | 3.19 | 4.97 |
| Outer Avg. | 6.72 | 1.45 | 6.64 | 5.93 |
| Grand Avg. | 6.65 | 1.44 | 7.09 | 6.09 |

Table 11

Food Preference Survey

Mean Hedonic Preference and Preferred Frequency Scores

| | Before *Experiment* | Mid *Experiment* | End of *Experiment* |
|---|---|---|---|
| Hedonic Preference | | | |
| Inner 4 | 6.5 | 6.2 | 6.3 |
| Outer 8 | 6.7 | 6.5 | 6.5 |
| Total 12 | 6.7 | 6.4 | 6.4 |
| Preferred Frequency | | | |
| Inner 4 | 7.3 | 5.0 | 6.0 |
| Outer 8 | 6.1 | 4.1 | 3.9 |
| Total 12 | 6.6 | 4.5 | 4.4 |

between the second and third administrations, both of which occurred during the experiment. As shown, both the mean hedonic preference and mean preferred frequency were lower on the second Survey. This decrease, which occurred in all crewmembers except the older P.I. was accompanied by a decrease in the variability of both scores. There was also a marked decrease in the correlation between hedonic preference and preferred frequency scores, from 0.60 on the first, to 0.51 on the third administration. As discussed below, the scores from the Surveys administered during the experiment are better predictors of food choice. There are no data available to indicate the reason for this shift, although two explanations seem more likely than others. The shift may reflect a "practice effect" independent of any of the characteristics of habitation, or it may reflect an "anchor" or "point of reference" effect. At the initial administration of the Survey, individuals had no consistent quality standards to base their judgements on, whereas by the fourth day of the experiment they may have referred most judgments to the average quality of the food being served in the habitat.

A number of correlations between Survey scores and probability of food item selection were calculated. They are, however, all based on skewed distributions, and in most cases their numeric values are lowered as an artifact of one of the major characteristics of the experiment. There was a large number of food items available, and a limited number of meals in which to choose these items. As a consequence, there were not enough opportunities for an individual to select all his high preference items, even once. Thus the scattergrams, particularly hedonic preference scores reveal a very curvilinear relationship. A typical plot for hedonic preference scores is shown in Figure 5, and for preferred frequency scores in Figure 6. The preferred frequency scores form a more statistically adequate distribution, and as a direct consequence, the correlation coefficients between preferred frequency scores and probability of selection are numerically higher.

Table 12 shows that preferred frequency scores from all three Surveys were more highly correlated with choice than were any of the hedonic preference scores. Preferred frequency scores from the second and third Surveys are also better correlated with choice than those from the first Survey. The fact that the mean preferred frequency score has the highest correlation is mostly due to the contribution of the second and third surveys.

Fig. 5

Correlation scatter diagram for probability of food item selection as related to the Hedonic Preference value of that item for one Crewmember. The large number of zero probability items numerically reduces the correlation coefficient

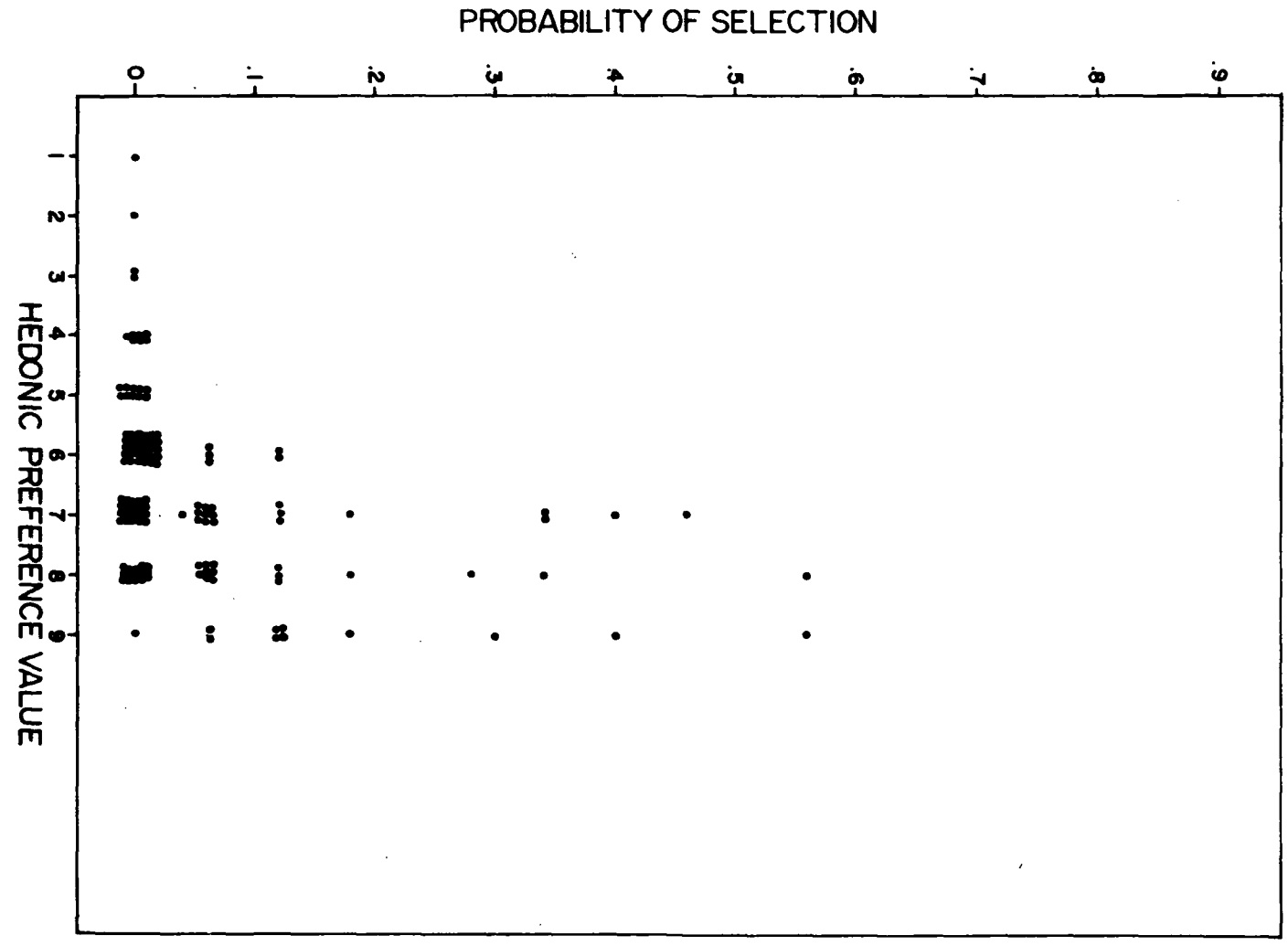


Fig. 6

Correlation scatter diagram for the probability of food item selection as related to the Preferred Frequency of that item

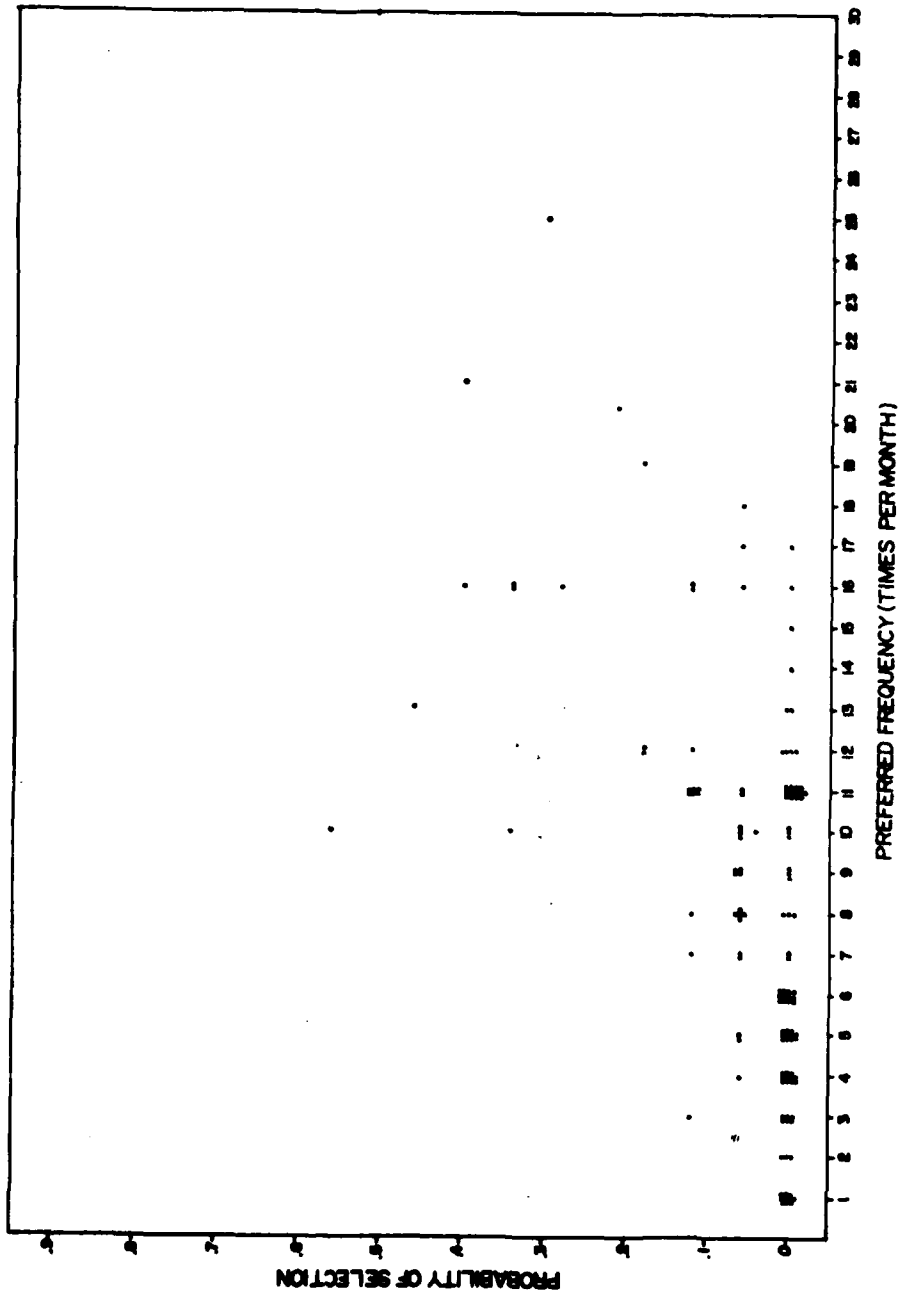


Table 12

Correlations Between Hedonic Preference and Preferred Frequency Scores and Overall Probability of Item Selection

| | Inner 4 | Outer 8 | Total 12 |
|---|---|---|---|
| Pre-Exp. Hedonic Preference | 0.35 | 0.30 | 0.31 |
| Mid-Exp. Hedonic Preference | 0.40 | 0.35 | 0.37 |
| End-Exp. Hedonic Preference | 0.41 | 0.32 | 0.35 |
| Pre-Exp. Preferred Frequency | 0.55 | 0.49 | 0.51 |
| Mid-Exp. Preferred Frequency | 0.68 | 0.58 | 0.61 |
| End-Exp. Preferred Frequency | 0.65 | 0.58 | 0.60 |
| Mean Hedonic Preference | 0.40 | 0.35 | 0.36 |
| Mean Preferred Frequency | 0.66 | 0.59 | 0.62 |
| Z end P. + Z end F. | 0.60 | 0.54 | 0.56 |

Table 13 shows that, for some individuals, the mid-experiment preferred frequency score was the better predictor of choice, while for others it was the end-experiment score, and for one individual, Outcrewman #2 whose unusual pattern of judgements was described earlier, the pre-experiment preferred frequency was the best predictor.

When the pattern of correlations is examined for food classes, Table 14, the picture is not quite so clear. In 21 of the 25 classes, the end-experiment preferred frequency score is most highly correlated with choice, although in two classes the correlation is no higher than with the pre-experiment preferred frequency scores. In four classes; Beer, Breakfast Cereals and Griddle Cakes, Breakfast Meats, and Cookies, Brownies and Cakes, hedonic preference scores are more highly correlated with choice than are preferred frequency scores. In the case of beer, there was only one item in the class, and in the other three cases there were a limited number of items, some of which were of near universal low hedonic preference value. As a consequence, for each of these classes there were ample opportunities to select all the high hedonic preference items, allowing the correlation to reflect the unrestricted discrimination among items.

FOOD PREFERENCE SURVEY: SUMMARY. In this experiment then the best general predictor of food item choice was the preferred frequency rating score from a Survey completed during habitation. The extent to which this superiority over hedonic preference scores would occur in a longer habitation, or with a more limited menu simply cannot be determined from these data, although it is likely that the hedonic preference rating scores correlations were artifactually reduced by the design of this experiment. Even in this experiment, however, the correlations between food choice and hedonic preference scores from the second and third Surveys (during habitation) were higher than those from the first Survey (before habitation).

FOOD CONSUMPTION DIARY

Differences were found between the general composition of the daily food consumption diaries recorded by the Inner 4 crewmen and the composition of the diaries recorded by the Outer 8. One cause for these differences may have been the dissimilarity of the schedules of the two crews. The Inner 4 were working within a strict regimen including regular working hours, specific meal time windows at intervals which

Table 13

Correlations Between Preferred Frequency Scores and Probability of Selection for Individuals

| Crewmember | Pre-Experiment Preferred Freq. | Mid-Experiment Preferred Freq. | End of Experiment Preferred Freq. | Mean Preferred Freq. |
|---|---|---|---|---|
| Inner 1 | 0.65 | 0.72 | 0.76 | 0.76 |
| Inner 2 | 0.41 | 0.67 | 0.51 | 0.56 |
| Inner 3 | 0.48 | 0.60 | 0.68 | 0.62 |
| Inner 4 | 0.65 | 0.73 | 0.64 | 0.72 |
| Outer 1 | 0.52 | 0.78 | 0.77 | 0.73 |
| Outer 2 | 0.31 | 0.21 | 0.24 | 0.30 |
| Outer 3 | 0.57 | 0.60 | 0.59 | 0.60 |
| Outer 4 | 0.40 | 0.54 | 0.59 | 0.55 |
| Outer 5 | 0.53 | 0.59 | 0.63 | 0.62 |
| Outer 6 | 0.52 | 0.72 | 0.61 | 0.71 |
| Outer 7 | 0.54 | 0.61 | 0.60 | 0.64 |
| Outer 8 | 0.57 | 0.56 | 0.62 | 0.60 |
| Inner Mean | 0.55 | 0.68 | 0.65 | 0.66 |
| Outer Mean | 0.49 | 0.58 | 0.58 | 0.59 |
| Grand Mean | 0.51 | 0.61 | 0.60 | 0.62 |

Table 14

Correlations Between Hedonic Preference and Preferred Frequency Scores as a Function of Food Class

| Food Class | | Pre-Experiment | | End-Experiment | |
|---|---|---|---|---|---|
| | | Hedonic Preference | Preferred Frequency | Hedonic Preference | Preferred Frequency |
| 01 | Soups | 0.25 | 0.25 | 0.27 | 0.28* |
| 02 | Juices, Fruit and Vegetable | 0.63 | 0.68* | 0.63 | 0.68* |
| 03 | Drinks, Iced Coffee, Iced Tea | 0.71 | 0.63 | 0.73 | 0.79* |
| 04 | Hot Beverages | 0.43 | 0.58 | 0.45 | 0.65* |
| 05 | Milk Products | 0.41 | 0.68 | 0.52 | 0.86* |
| 06 | Beverages, Carbonated | 0.37 | 0.68 | 0.43 | 0.69* |
| 07 | Beer | 0.17 | 0.12 | 0.39* | 0.34 |
| 08 | Hot Breads, Donuts | 0.21 | 0.22 | 0.29 | 0.33* |
| 09 | Breakfast Cereals, Griddle | 0.32 | 0.40 | 0.49* | 0.37 |
| 10 | Eggs | 0.60 | 0.80 | 0.56 | 0.83* |
| 11 | Breakfast Meats | 0.25 | 0.40 | 0.60* | 0.58 |
| 12 | Fish and Seafoods | 0.39 | 0.45 | 0.47 | 0.48* |
| 13 | Meats | 0.34 | 0.44* | 0.35 | 0.44* |
| 14 | Stews & Extended Meats | 0.21 | 0.20 | 0.34 | 0.60* |
| 15 | Short Orders, Sandwiches | 0.30 | 0.28 | 0.29 | 0.34* |

*Highest correlation within food class

Table 14 (Continued)

Correlations Between Hedonic Preference and Preferred Frequency Scores as a Function of Food Class

| Food Class | | Pre-Experiment | | End-Experiment | |
|---|---|---|---|---|---|
| | | Hedonic Preference | Preferred Frequency | Hedonic Preference | Preferred Frequency |
| 16 | Potato and Potato Substitutes | 0.34 | 0.24 | 0.32 | 0.38* |
| 17 | Green Vegetables | 0.32 | 0.29 | 0.35 | 0.38* |
| 18 | Yellow and other Vegetables | 0.37 | 0.39 | 0.34 | 0.40* |
| 19 | Salads, Vegetable and Green | 0.28 | 0.50 | 0.42 | 0.60* |
| 20 | Salad Dressing | 0.43 | 0.46 | 0.51 | 0.60* |
| 21 | Fruit | 0.30 | 0.25 | 0.32 | 0.33* |
| 22 | Cookies, Brownies, Cakes | 0.58* | 0.28 | 0.56 | 0.44 |
| 23 | Pies | 0.54 | 0.58 | 0.58 | 0.73* |
| 24 | Ice Cream, Pudding | 0.36 | 0.36 | 0.38 | 0.65* |
| 25 | Snacks, Candy | | | | |

*Highest correlation within food class.

matched those of the quadrants in which the diary was divided, and a record keeping period scheduled for nine o'clock each morning. Their diaries reflect the orderly structure within which they worked. The Outer 8, on the other hand, worked within a far less regimented schedule. Their diverse duties prevented a regular record keeping period and though they conformed to meal time windows as closely as possible, occasionally meal times were postponed, or completely missed. Their diaries are much less organized and duplications of food items were found when meals and snacks were eaten at odd hours. These duplications were eliminated from the diary data.

Another large difference was discovered in the diaries between the Inner and Outer crews in their accuracy in recording the number and amount of food items consumed. The Outer 8 made a greater number of misrecordings (food items consumed but not recorded in the diaries, or food items recorded but not actually consumed), than did the Inner 4, possibly because the Outer crewmembers handled large quantities of food other than their own. Interestingly, they made smaller errors in estimating the amount in ounces of their servings. This is perhaps due to the fact that they weighed other crewmembers food, even though it was weighed in grams. They also were familiar with the size (in ounces) of the containers in which the food was served.

In addition, a "revised diary" was produced by making a few changes in the diary data. On the menu there were several items which were very similar to other items but had different names. Some examples are hot rolls and biscuits, frozen peas and canned peas, spinach and turnip greens. The item name in the diary was changed to match the name of the item actually consumed, if the items were within the same class and the difference was trivial and semantic. (See Appendix D for list of all changes in item name.) Also, servings of milk were omitted when recorded in a diary as a supplement with cereal or fruit when the actual data did not show milk as a separate item.

The value of the "revised diary" is that it provides data on the items misrecorded which are not trivial in their difference from the actual data. A clearer estimation is given of the discrepancies which can be expected from food consumption diaries.

The 158 food items which were used in this experiment were drawn from 25 different food classes. (24 food classes were used, salad dressing being excluded because it was reported in a procedurally

different manner.) To facilitate the presentation and comprehension of the diary related results, these classes were further divided into five Food Groups based on the nutritional composition of the items in each class. In Table 15, the five Food Groups are listed along with the classes in each Group. These Groups are represented in Figure 7 by the number of calories consumed in each Food Group as a percentage of the total number of calories consumed in all Groups. The Milk and Meat Group comprised 41% of all calories consumed; the Starch Group, 19%; the Beverage Group, 19%; the Sweets Group, 13%; and the Vegetable and Fruit Group, 8%.

In analyzing the data from the food consumption diaries many formulae and technical terms are used. Appendix E contains descriptions of these terms and the formulae.

ERROR IN RECORDING THE NUMBER OF SERVINGS. A comparison of the gross or total number of servings actually consumed and those recorded in the diaries is shown in Table 16. The Gross Percentage of the Difference in each Food Group is also given. In all Food Groups, for the Total 12 crewmembers, the recorded number of servings is lower than the actual number consumed. The Gross Percentages of the Differences range from -4.13% in the Beverage Group to -32.20% in the Sweets Group.

The Inner 4 have a smaller Gross Percentage of the Difference in every Food Group than the Outer 8, except in the Beverage Group where more than half of the error for the Inner 4 is in the carbonated beverage class. The Milk and Meat Group, for the Inner 4, shows a Gross Percentage of the Difference of zero, but within this group the milk products and ice cream classes each have a small number of errors which cancel each other. In the Vegetable and Fruit Group no error is found for the green vegetables and salads classes, and in the Starch Group there is no error for the breakfast cereals, griddle cake class. The number of errors in the snacks class within the Sweets Group largely contributes to the Gross Percentage of the Difference for the Inner 4 crewmen.

The Outer 8 are less accurate in recording the number of servings but the differences tend to occur within the same Groups and classes. Within the Milk and Meat Group, the greatest number of errors occur in the milk products and ice cream classes as they did for the Inner 4.

Table 15

Food Groups and the Classes Within Each Group

I. MILK AND MEATS

- 05 Milk Products
- 24 Ice Cream, Pudding
- 10 Eggs
- 11 Breakfast Meats
- 12 Fish and Seafoods
- 13 Meats
- 14 Stews and Extended Meats
- 15 Short Order, Sandwiches

II. VEGETABLES AND FRUITS

- 01 Soups
- 02 Juices, Fruit and Vegetable
- 17 Green Vegetables
- 18 Yellow and other Vegetables
- 19 Salads, Veg. and Green
- 21 Fruits

III. STARCHES

- 08 Hot Breads, Donuts
- 09 Breakfast Cereals, Griddle
- 16 Potato and Potato Substitutes

IV. SWEETS

- 22 Cookies, Brownies, Cakes
- 23 Pies
- 25 Snacks, Candy

V. BEVERAGES

- 03 Drinks, Iced Coffee, Iced Tea
- 04 Hot Beverages
- 06 Beverage, Carbonated
- 07 Beer

Fig. 7

Percentage of total calories in each food group

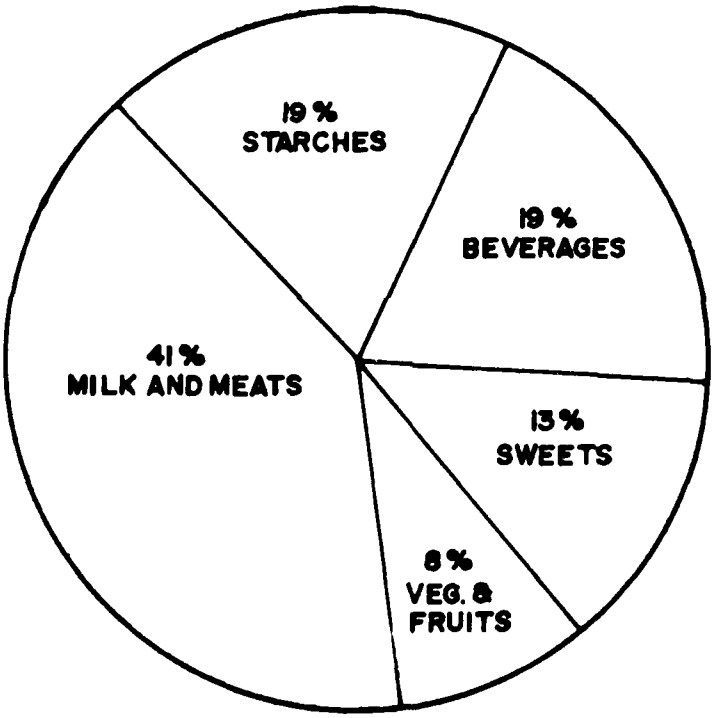


Table 16

Gross Number of Servings (Actual and Recorded)
and the Gross Percentage of the Difference for Diary Data

| Food Groups | Inner 4 | | | Outer 8 | | | Total 12 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Act | Dia | % | Act | Dia | % | Act | Dia | % |
| Milk and Meats | 161 | 161 | 0 | 262 | 233 | -10.38 | 421 | 394 | - 6.41 |
| Vegetables and Fruits | 101 | 95 | - 5.94 | 222 | 180 | -18.92 | 323 | 275 | -14.86 |
| Starches | 109 | 103 | - 5.50 | 180 | 151 | -16.11 | 289 | 254 | -12.11 |
| Sweets | 48 | 33 | -31.25 | 70 | 47 | -32.89 | 118 | 80 | -32.20 |
| Beverages | 277 | 255 | - 7.94 | 497 | 487 | - 2.01 | 774 | 742 | - 4.13 |

In the Vegetable and Fruit Group, less error is found in the green vegetables and salads classes, and within the Starches Group, there is no error for the breakfast cereals, griddle cakes class. However, in the Sweets Group, though the Gross Percentage of the Difference is approximately the same as for the Inner 4, the error is more evenly distributed among the classes. In the Beverage Group, the only Group in which the Outer 8 were more accurate, their error is greatest for the iced tea class.

The Gross Percentages of the Difference for the "revised diary", shown in Table 17, are very nearly the same as for the diary. Furthermore, the pattern of error is retained throughout Groups and classes. The trivial errors corrected to produce the "revised diary" seem to have little effect on the overall number and pattern of errors.

Table 18 shows the Algebraic and Arithmetic Sums of the number of individual misrecordings, both understatements (food items actually consumed but not recorded in the diaries) and overstatements (food items recorded but not actually consumed).

The Algebraic Sum takes into account whether the misrecording is an overstatement or an understatement, giving the residual number of misrecordings. The Arithmetic Sum disregards the direction of the misrecordings, merely counting their number, giving the total number of errors. For both crews, in every Food Group, there was a greater number of understatements made except in the Milks and Meats Group for the Inner 4. In fact, within this Group, in all meat classes, the Inner 4 made no misrecordings at all. All errors were made in the milk products and ice cream classes. It is within these same classes plus the short order sandwiches class that the Outer 8 made most of their errors.

The total number of errors always exceeds the residual (algebraic) number of errors (except in the Sweets Group where they are equal), and is noticeably greater in the Beverage Group for the Outer 8.

Table 19 lists the average number of individual misrecordings of a food item within a Food Group as a proportion of the average number of servings of a food item actually consumed in that Group.

The Algebraic Average Proportions indicate once again that misrecordings are more frequently understatements. The Arithmetic Average

Table 17

Gross Percentage of the Difference

for the "Revised" Diary

| Food Groups | Revised Diary % Inner 4 | Outer 8 | Total 12 |
|---|---|---|---|
| Milk and Meats | 0 | -12.31 | - 7.60 |
| Vegetables and Fruits | - 5.94 | -18.47 | -14.55 |
| Starches | - 5.50 | -16.67 | -12.46 |
| Sweets | -31.25 | -32.86 | -32.20 |
| Beverages | - 7.94 | - 2.21 | - 4.26 |

Table 18

Algebraic and Arithmetic Sum of Misrecordings

| Food Groups | Inner 4 | | Outer 8 | | Total 12 | |
|---|---|---|---|---|---|---|
| | Alg. | Arith. | Alg. | Arith. | Alg. | Arith. |
| Milk and Meats | 0 | 14 | -27 | 53 | -27 | 67 |
| Vegetables and Fruits | - 6 | 14 | -42 | 66 | -48 | 80 |
| Starches | - 6 | 22 | -29 | 57 | -35 | 79 |
| Sweets | -15 | 15 | -23 | 27 | -38 | 42 |
| Beverages | -22 | 46 | -10 | 172 | -32 | 218 |

Table 19

Algebraic and Arithmetic Average Proportion of Misrecordings

| Food Groups | Diary | | | | | | Revised Diary | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Algebraic | | | Arithmetic | | | Algebraic | | | Arithmetic | | |
| | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 |
| Milk and Meats | -.01 | -.14 | -.09 | .06 | .18 | .13 | -.01 | -.14 | -.09 | .03 | .17 | .12 |
| Vegetables and Fruits | -.12 | -.18 | -.16 | .14 | .26 | .23 | -.08 | -.15 | -.11 | .10 | .20 | .17 |
| Starches | -.02 | -.11 | -.13 | .14 | .26 | .26 | -.02 | -.13 | -.12 | .08 | .20 | .17 |
| Sweets | -.30 | -.40 | -.34 | .30 | .44 | .37 | -.30 | -.35 | -.29 | .30 | .37 | .30 |
| Beverages | -.12 | -.20 | -.20 | .16 | .36 | .32 | -.13 | -.21 | -.22 | .15 | .35 | .31 |

Proportions are average probabilities of misrecordings of averaged items within each Food Group, and are generally larger than the Gross Percentages of the Difference because they more closely represent the occurrence of each isolated misrecording. These probabilities vary for the total 12 crewmembers from a 0.13 chance of error for the Milks and Meats Group to a 0.37 chance of error for the Sweets Group. They indicate the same pattern of errors among Groups as the Gross Percentages of the Difference, as well as similar differences between Inner and Outer crews. The only exception is the Beverage Group in which the Outer 8 made a smaller Gross Percentage of the Difference than the Inner 4. The Arithmetic Average Proportion of misrecordings for this group is greater for the Outer 8 than for the Inner 4 which is explained by the large Arithmetic Sum of misrecordings that was shown in Table 18.

The Arithmetic Average Proportions are less in the "revised diary" because the total number of errors (the Arithmetic Sum of misrecordings) decreased due to the item name changes which erased trivial discrepancies.

ERROR IN WEIGHT ESTIMATION. In the diaries, the amount by weight consumed for each serving was estimated in ounces (except for Increwman #1). These estimations were translated into grams and in Table 20 the gross recorded amounts are compared to the gross amounts actually consumed. For the Total 12 in each Food Group, except the Starch Group, the amount recorded in the diaries is less than the amount actually consumed. To some extent this is because the gross recorded number of servings is less than the gross actual number of servings consumed. Since the number of servings recorded for the Starch Group was also understated, the overestimation of amount must indeed be great.

The Gross Percentages of the Difference in amount are shown in Table 21. For the Total 12 they range from -12.99% for the Sweets Group to +16.99% for the Starch Group for the diary estimations. Only slight differences are seen in the "revised diary" figures for the Gross Percentage of the Difference in amount.

The smallest Gross Percentage of the Difference occurs in the Milk and Meat Group, but within this group there are errors which cancel each other, the recorded amount being greater than the actual for the meat classes and less than the actual for the milk classes. The result of cancellation occurs also in the Vegetable and Fruit Group

Table 20

Gross Amount Consumed in Grams

(Actual and Recorded)

| Food Groups | Inner 4 | | Outer 8 | | Total 12 | |
|---|---|---|---|---|---|---|
| | Actual | Diary | Actual | Diary | Actual | Diary |
| Milk and Meats | 28770 | 28468 | 47002 | 47175 | 75772 | 75643 |
| Vegetables and Fruits | 16211 | 15901 | 37441 | 32480 | 53652 | 48381 |
| Starches | 6837 | 10534 | 15023 | 15039 | 21860 | 25573 |
| Sweets | 4316 | 3570 | 9077 | 8083 | 13393 | 11653 |
| Beverages | 59237 | 48296 | 135697 | 129821 | 194934 | 178117 |

Table 21

Gross Percentage of the Difference

in Amount (Diary and Revised Diary)

| Food Groups | Diary | | | Revised Diary | | |
|---|---|---|---|---|---|---|
| | Inner 4 | Outer 8 | Total 12 | Inner 4 | Outer 8 | Total 12 |
| Milk and Meats | - 1.05 | 0.37 | - 0.17 | - 1.05 | - 1.07 | - 1.06 |
| Vegetables and Fruits | - 1.91 | -13.25 | - 9.82 | - 1.91 | -12.72 | - 9.46 |
| Starches | +54.07 | .11 | +16.99 | +54.07 | - 1.21 | +16.08 |
| Sweets | -17.28 | -10.95 | -12.99 | -17.28 | -10.95 | -12.99 |
| Beverages | -18.47 | - 4.33 | - 8.63 | -18.47 | - 4.52 | - 8.76 |

where the recorded amounts are greater than the actual for the vegetable classes and less than the actual for the fruit, juice and soup classes. Looking across all Groups and classes, a pattern of underestimation for liquid items and overestimation for solid items appears. This explains why the classes within the Starch, Sweets, and Beverage Groups are consistent with their Group Gross Percentage of the Difference. The main reason Sweets, although they are solids, show a large underestimation is the fact that their number of servings were understated in the diaries. A look at the weight estimations isolated from the number of misrecordings will make this apparent.

Table 22 lists the Algebraic and Arithmetic Sums of the differences between the average amount of a serving per day actually consumed and the average amount of a serving per day estimated in the diaries for items in each Food Group. These sums of estimation error disregard those items which were misrecorded, referring only to the cases in which both recorded estimation and actual consumption occurs.

The Algebraic Sums for the Total 12, which take into account whether the amount of weight is overestimated or underestimated, indicate that the weight of the average item in all Food Groups, except the Beverage Group, is overestimated more often than underestimated. Of course, the total number of grams in error, the Arithmetic Sums, are substantially larger than the Algebraic Sums.

The Algebraic and Arithmetic Sum of estimation error for each food item written as a proportion of the average amount of a serving actually consumed and averaged for a day gives the Algebraic and Arithmetic Average Proportion of estimation error for each food item. These proportions, totaled and averaged for each Food Group are shown in Table 23.

An example of the calculations used to produce Tables 22 and 23, is shown in Appendix F. This example also clarifies the apparent discrepancy between these tables with respect to the Sweets Group for the Inner 4.

The Arithmetic Average Proportions indicate the proportion of error in estimating the amount of a daily average serving of an average item within a Food Group. The Algebraic Average Proportion gives the proportion of overestimation or underestimation when many servings of

Table 22

Algebraic and Arithmetic Sum of Estimation Error

| Food Groups | Inner 4 | | Outer 8 | | Total 12 | |
|---|---|---|---|---|---|---|
| | Alg. | Arith | Alg. | Arith | Alg. | Arith |
| Milk and Meats | 2263 | 15099 | 5813 | 16393 | 8076 | 31490 |
| Vegetables and Fruits | -707 | 7776 | 1811 | 9932 | 1104 | 17709 |
| Starches | 3959 | 5448 | 1573 | 5776 | 5531 | 11223 |
| Sweets | -111 | 2735 | 1070 | 2166 | 959 | 4901 |
| Beverages | -3707 | 7268 | -1309 | 6117 | -5016 | 13385 |

Table 23

Algebraic and Arithmetic Average Proportion of Estimation Error

| Food Groups | Diary | | | | | | Revised Diary | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Algebraic | | | Arithmetic | | | Algebraic | | | Arithmetic | | |
| | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 | 4 | 8 | 12 |
| Milk and Meats | .47 | .39 | .35 | .81 | .56 | .61 | .47 | .40 | .35 | .82 | .57 | .62 |
| Vegetables and Fruits | .00 | .06 | .04 | .47 | .27 | .34 | .07 | .07 | .08 | .55 | .30 | .38 |
| Starches | .50 | .19 | .26 | .90 | .39 | .52 | .50 | .19 | .26 | .93 | .42 | .52 |
| Sweets | .31 | .18 | .32 | .70 | .26 | .51 | .31 | .24 | .37 | .70 | .32 | .56 |
| Beverages | -.24 | -.08 | -.10 | .34 | .11 | .20 | -.24 | -.08 | -.10 | .34 | .13 | .20 |

the average item in that Group are considered.

For the Total 12, on the average, estimations of the amount consumed of single items in the Milk and Meat Group are 0.61 in error and the effect of these errors on many servings results in a 0.35 overestimation. The classes within this Group vary from the Group Average Algebraic and Arithmetic Proportions, with less error occurring in the milk products class, and these errors being underestimations since milk is a liquid. Juices, within the Vegetable and Fruit Group, vary similarly. However, the soups class within this Group, although underestimated, show a large amount of error. Possibly the weight of the liquids are generally estimated by the volume of the container in which they are served. For water this is a very accurate estimation, but as the specific gravity of the liquid increases above that of water, the estimation becomes less accurate. Soups, then, have a relatively large Algebraic and Arithmetic Average Proportion of error.

The Algebraic and Arithmetic Average Proportions for the Sweets and Starch Groups also show relatively large overestimations and total number of errors, especially compared to the Beverage Group which has an Algebraic Average Proportion of -0.10 and an Arithmetic Average Proportion of 0.20.

A second pattern of error is seen, in that generally the estimated weights of liquids consumed have a smaller proportion of error than estimated weights of solids. This varies according to the specific gravity of the liquid.

Both patterns of error are consistent throughout Inner and Outer crews, though the average proportion of error in estimating amounts are smaller for the Outer 8 than for the Inner 4. The difference in estimation errors between the two crews is greatest for the Beverage Group where the Outer 8 proportion is three times smaller than the Inner 4 proportion. The Outer 8 were perhaps more familiar than the Inner 4 with the size in ounces of the containers in which the beverages were served.

The average proportions of error in the "revised diary" are universally equal to or larger than those in the diary. This is apparently due to the decrease in the number of misrecordings which allows more weight estimations to be compared to the actual amounts consumed.

ESTIMATION ERROR IN TERMS OF CALORIES. To gain a perspective on the number of calories involved in the errors made in estimating the weight of food items consumed, the amount in grams for each food item was calorated. That is, the amount in grams, consumed and recorded, was translated into the number of calories by using the caloric intensity per gram for each food item in the data.

Table 24 lists the gross calorated amounts actually consumed and recorded in the diaries for each Food Group. When these calorated amounts are compared to the amounts in grams listed in Table 20, it can be seen that the pattern of the differences between the actual and recorded calorated amounts is not the same as the pattern of the differences for the amounts in grams. For the Milk and Meats Group this is especially apparent because the estimated amount in grams is smaller than the actual amount consumed while the calorated estimated amount is greater than the actual calorated amount consumed.

In Figure 8 the Gross Percentages of the Difference for amount in grams and calorated amounts are compared for each Food Group. It is obvious that these percentages are not the same, due to the varying caloric intensity of the food items in each Food Group. The differences between the percentages indicate that there is a definite relationship between weight estimation and caloric intensity. Since solids tend to have higher caloric intensities than liquids and solids are generally overestimated while liquids are generally underestimated, then overestimated items tend to have high caloric intensities and underestimated items tend to have low caloric intensities. Therefore, the relatively large overestimation indicated by the Gross Percentage of the Difference for the calorated amount for the Milk and Meats Group is understandable. The meat classes which are overestimated in weight have a high average caloric intensity and the milk classes which are underestimated in weight (which causes the cancellation resulting in such small weight estimation error for the group) have a low average caloric intensity.

This relationship appears to be consistent throughout the calorated data with the exception of vegetables. Though they are solids, vegetables have a relatively low caloric intensity. All classes within the Vegetable and Fruit Group, whether solids or liquids, have approximately the same average caloric intensity. Since the soup class has a large weight underestimation, and the greatest amount of grams was consumed in the juice class, which is underestimated, the Gross Percentage of the

Table 24

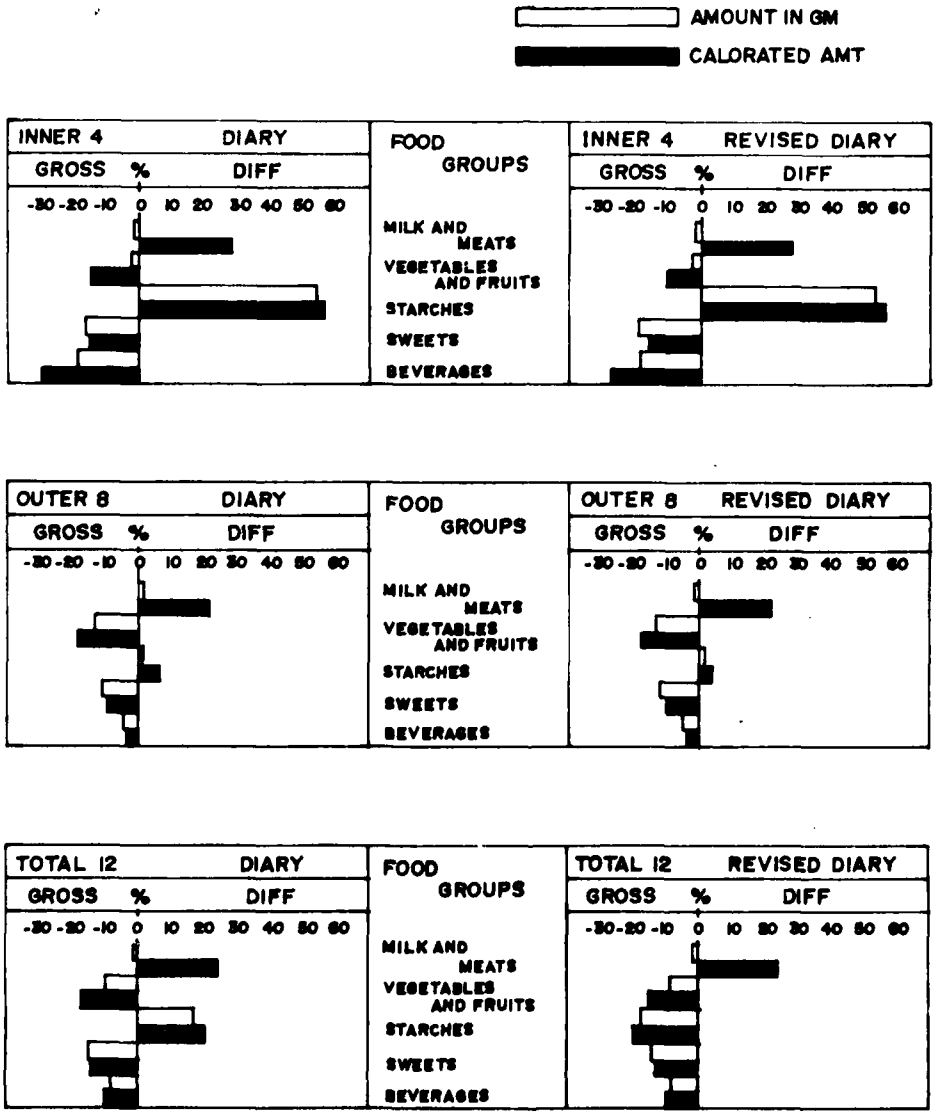
Gross Calorated Amounts

(Actual and Recorded)

| Food Groups | Inner 4 | | Outer 8 | | Total 12 | |
|---|---|---|---|---|---|---|
| | Actual | Diary | Actual | Diary | Actual | Diary |
| Milk and Meats | 49638 | 63272 | 73005 | 88219 | 122643 | 151490 |
| Vegetables and Fruits | 7616 | 6579 | 17879 | 14650 | 25495 | 21229 |
| Starches | 17007 | 26467 | 40443 | 42498 | 57450 | 68965 |
| Sweets | 12419 | 10492 | 26265 | 23668 | 38684 | 34160 |
| Beverages | 14073 | 9931 | 42696 | 41261 | 56770 | 51192 |

Fig. 8

Comparison of Gross Percentage of the Difference
for amounts and calorated amounts



Difference for the calorated amounts show a larger underestimation than the Gross Percentage of the Difference for the amounts in grams.

The Gross Percentages of the Difference for calorated amounts in the other food groups are more nearly the same as the Gross Percentages of the Differences for the amounts in grams, their estimation errors and caloric intensities being consistent throughout the classes because they are either all solids or all liquids.

In comparing the Gross Percentages of the Difference for the Inner and Outer crew, the same relationship between weight estimation and caloric intensity is evident. However, for the Beverage Group for the Inner 4, the Gross Percentage of the Difference for calorated amounts is greater than the Gross Percentage of the Difference for the amounts in grams, while the Gross Percentage of the Difference for the calorated amounts for the Outer 8 is less than the percentage for the amounts in grams. This is due to the large estimation error for the Inner 4 in the carbonated beverage class within the Beverage Group. This class has a relatively high average caloric intensity as compared to other beverages which causes a greater Gross Percentage of the Difference for the calorated amounts in that Food Group.

The Gross Percentages of the Difference for the "revised diary" vary slightly from those for the diary but due to the item name changes which allow correct caloric intensities to be used, they reflect more closely the relationship between weight estimation and caloric intensity.

The Algebraic and Arithmetic Average Proportions of estimation error, which account for the individual discrepancies, are identical for both weight estimation and calorated estimation.

AVERAGE RATIOS OF ERROR. The average ratios of error for all food items are shown in Table 25 for misrecordings, estimation errors, and calorated errors. The Gross Percentage of the Difference is a grand sum average in which the data for all food items recorded in the diaries are summed up and compared to the data for the total actual items consumed. The Algebraic and Arithmetic Average Proportions are individual average errors for each food item which have been summed up and averaged again for all food items recorded in the diaries compared to the items, amounts, and calorated amounts actually consumed.

Table 25

Average Ratios of Error for Total Food Items

| Selected Ratios | Diary | | | Revised |
|---|---|---|---|---|
| | Inner 4 | Outer 8 | Total 12 | Total 12 |
| Gross % Diff | | | | |
| Mis-Recordings | - 7.04 | -10.66 | -9.35 | -9.66 |
| Estimation Err | - 7.46 | - 4.77 | -5.63 | -5.89 |
| Calorated Err | +15.87 | + 5.00 | +8.63 | +8.64 |
| Alg. Avg. Proportion | | | | |
| Mis-Recordings | - 0.09 | - 0.18 | - 0.14 | - 0.13 |
| Estimation Err | 0.29 | 0.22 | 0.23 | 0.25 |
| Arith. Avg. Proportion | | | | |
| Mis-Recordings | 0.13 | 0.26 | 0.21 | 0.17 |
| Estimation Err | 0.70 | 0.40 | 0.49 | 0.52 |

The Inner 4 crewmen have smaller ratios of error than the Outer 8 for misrecordings but larger ratios of errors than the Outer 8 for estimation errors and calorated errors. This indicates that the Inner 4 show greater accuracy at recording food items than the Outer 8, and the Outer 8 show greater accuracy at estimating amounts than the Inner 4. The reasons for this occurrence may well be the difference in schedules for the Outer 8 and their familiarity with weights gained from handling others' food.

The calorated error expressed in the Gross Percentage of Difference indicates a larger divergence from estimation error for the Inner 4 than for the Outer 8. This is caused chiefly by the large weight overestimation for the Inner 4 for the Starch Group which has a high average caloric intensity.

The results of the "revised diary" show a greater Gross Percentage of the Difference for misrecordings and estimation error, caused by the omissions of milk; smaller Algebraic and Arithmetic Average Proportions for misrecordings due to item name changes; and greater Algebraic and Arithmetic Average Proportions for estimation errors because more grams were available for comparison, also due to item name changes.

These ratios, though they differ only slightly from those for the recorded diary, represent, more nearly, the fundamental errors found in food consumption diaries.

FOOD CONSUMPTION DIARY: SUMMARY. In comparing actual and recorded food consumption, errors were found both in reporting the consumption of a food item and in estimating the amount consumed. Several factors influence the occurrence of these errors. An error in reporting a food item was more often due to a failure to record that food item in the diary, and generally a structured and regular work schedule increased the accuracy with which food items were reported. Errors in estimating the amount consumed tended to be overestimations if the food item was a solid and tended to be underestimations if the food item was a liquid. The estimated amount of a liquid, which may have been determined by the volume of the container in which it was served, was generally more accurate than the estimated amount of a solid, but this varied according to the specific gravity of the liquid. The differences between the amount of calories actually consumed and the estimated amount of calories derived from the weight estimations, also, depended

largely upon the consistency of the food items. Solids, generally, had a higher caloric intensity and a larger estimation error than liquids resulting in a greater difference between actual and estimated amount of calories for solids than for liquids. Furthermore, the amount of calories in solids were overestimations of actual consumption and underestimations for liquids.

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Appendix A

Availability and Serving Size of Foods

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 01 | Soups | | | | | | |
| | Tomato Soup | | L | D | | 264 | 4 |
| | Onion Soup | | L | D | | --- | 0 |
| | Split Pea Soup | | L | D | | --- | 0 |
| 02 | Juices, Fruit and Vegetable | | | | | | |
| | Tomato Juice | B | L | D | S | 327 | 7 |
| | Orange Juice | B | L | D | S | 331 | 77 |
| | Prune Juice | B | | | | --- | 0 |
| 03 | Drinks, Iced Coffee and Iced Tea | | | | | | |
| | Iced Coffee | | L | D | S | --- | 0 |
| | Iced Tea | | L | D | S | 428 | 36 |
| 04 | Hot Beverages | | | | | | |
| | Hot Chocolate | B | L | D | S | 312 | 4 |
| | Hot Tea | B | L | D | S | 176 | 6 |
| | Hot Coffee | B | L | D | S | 182 | 214 |
| 05 | Milk Products | | | | | | |
| | Milk | B | L | D | S | 415 | 66 |
| | Fruit Flavored Yogurt | | | | S | 225 | 5 |
| | Swiss Cheese | | | | S | --- | 0 |
| | Cheddar Cheese | | | | S | 70 | 3 |
| 06 | Beverages, Carbonated | | | | | | |
| | Cola | | L | D | S | 423 | 71 |
| | Seven-Up Soda | | L | D | S | 437 | 7 |
| | Root Beer | | L | D | S | 421 | 6 |
| | Lo Cal Soda | | L | D | S | --- | 0 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 07 | Beer | | | | | | |
| | Beer | | L | D | S | 407 | 156 |
| 08 | Hot Breads, Donuts | | | | | | |
| | Hot Rolls | | L | D | | 44 | 18 |
| | Sweet Rolls | B | | | | 72 | 9 |
| | French Bread | | L | D | | 163 | 19 |
| | Rye Bread | | L | D | | 35 | 1 |
| | Dark Bread | | L | D | | 50 | 8 |
| | White Bread | | L | D | | 30 | 3 |
| | Baking Powder Biscuits | B | L | D | | 68 | 9 |
| | Buttered Toast | B | | | | 45 | 28 |
| | Donuts | | | | S | 68 | 13 |
| 09 | Breakfast Cereals, Griddle Cakes | | | | | | |
| | Griddle Cakes | B | | | | 111 | 8 |
| | Waffles | B | | | | 129 | 8 |
| | Heartland Natural Cereal | B | | | | 247 | 5 |
| | Grape Nuts Cereal | B | | | | 321 | 1 |
| 10 | Eggs | | | | | | |
| | Ham Omelette | B | | | | 233 | 3 |
| | Cheese Omelette | B | | | | --- | 0 |
| | Eggs to Order | B | | | | 119 | 32 |
| 11 | Breakfast Meats | | | | | | |
| | Ham (Breakfast) | B | | | | 70 | 12 |
| | Bacon | B | | | | 23 | 17 |
| | Sausage Links | B | | | | 46 | 9 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 12 | Fish and Seafoods | | | | | | |
| | Fried Clams | | L | D | | --- | 0 |
| | Seafood Platter | | L | D | | 177 | 1 |
| | Fried Shrimp | | L | D | | 228 | 12 |
| | Fried Fish | | L | D | | --- | 0 |
| | Fried Oysters | | L | D | | --- | 0 |
| 13 | Meats | | | | | | |
| | Veal Parmesean | | L | D | | 219 | 4 |
| | Sirloin Steak | | L | D | | 152 | 11 |
| | Roast Beef | | L | D | | 135 | 3 |
| | Roast Turkey | | L | D | | 196 | 3 |
| | Grilled Lamb Chops | | L | D | | 259 | 1 |
| | Braised Liver and Onions | | L | D | | 151 | 1 |
| | Fried Chicken | | L | D | | 292 | 3 |
| | Barbequed Chicken | | L | D | | 251 | 3 |
| | Salisbury Steak | | L | D | | 178 | 9 |
| | Grilled Ham Steak | | L | D | | 114 | 1 |
| | Chopped Round Steak | | L | D | | 144 | 2 |
| 14 | Stews and Extended Meats | | | | | | |
| | Macaroni and Beef Casserole | | L | D | | --- | 0 |
| | Lasagna | | L | D | | 285 | 2 |
| | Chili Con Carne | | L | D | | 288 | 3 |
| | Pork Chop Suey | | L | D | | 727 | 3 |
| | Corned Beef Hash | | L | D | | 348 | 1 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 14 | Stews and Extended Meats | | | | | | |
| | Spaghetti with Meat Sauce | | L | D | | --- | 0 |
| | Beef Pot Pie | | L | D | | --- | 0 |
| | Chinese Egg Roll | | L | D | | 144 | 3 |
| | Beef Straganoff | | L | D | | 243 | 1 |
| | Enchiladas | | L | D | | 255 | 3 |
| | Baked Beans and Franks | | L | D | | --- | 0 |
| | Shrimp Creole | | L | D | | 123 | 1 |
| 15 | Short Orders, Sandwiches | | | | | | |
| | Roast Beef Sandwich (cold) | | L | D | | 170 | 3 |
| | Tacos | | L | D | | 227 | 5 |
| | Onion Pizza | | L | D | | --- | 0 |
| | Tamale | | L | D | | 75 | 1 |
| | Ham Sandwich | | L | D | | 140 | 1 |
| | Cheeseburger | | L | D | | 278 | 3 |
| | Hamburger | | L | D | | --- | 0 |
| | Hot Dog | | L | D | | 102 | 1 |
| | Hot Pastrami Sandwich | | L | D | | --- | 0 |
| | Peanut Butter & Jelly Sand. | | L | D | | 126 | 1 |
| | B.L.T. Sandwich | | L | D | | 189 | 3 |
| | Mushroom Pizza | | L | D | | 352 | 2 |
| | Balogna Sandwich | | L | D | | --- | 0 |
| | Barbequed Pork Sandwich | | L | D | | 158 | 8 |
| | Hot Reuben Sandwich | | L | D | | 180 | 6 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 15 | Short Orders, Sandwiches | | | | | | |
| | Baked Bean Sandwich | | L | D | | --- | 0 |
| | Turkey Club Sandwich | | L | D | | 373 | 2 |
| | Tuna Fish Salad Sandwich | | L | D | | 172 | 2 |
| 16 | Potato and Potato Substitutes | | | | | | |
| | Crackers | | | | S | --- | 0 |
| | French Fried Potatoes | | L | D | | 127 | 4 |
| | Potato Salad (cold) | | L | D | | 116 | 3 |
| | Buttered Noodles | | L | D | | 133 | 6 |
| | Mashed Potatoes | | L | D | | 199 | 4 |
| | Refried Beans | | L | D | | 139 | 1 |
| | Pork Fried Rice | | L | D | | --- | 0 |
| | Baked Potato | | L | D | | 184 | 20 |
| | Pop Corn | | | | S | 35 | 2 |
| | Baked Beans | | L | D | | 217 | 1 |
| | Potato Chips | | L | D | S | 43 | 15 |
| | Sweet Potatoes | | L | D | | 189 | 2 |
| | Pretzels | | | | S | 48 | 6 |
| | Steamed Rice | | L | D | | 160 | 3 |
| | Grits | B | | | | 183 | 4 |
| 17 | Green Vegetables | | | | | | |
| | Turnip Greens | | L | D | | --- | 0 |
| | Frozen Peas | | L | D | | --- | 0 |
| | Brussel Sprouts | | L | D | | 145 | 5 |
| | Frozen Lima Beans | | L | D | | 152 | 1 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 17 | Green Vegetables | | | | | | |
| | Frozen Green Beans | | L | D | | 129 | 5 |
| | Buttered Zucchini Squash | | L | D | | --- | 0 |
| | Broccoli | | L | D | | 129 | 1 |
| | Spinach | | L | D | | 174 | 1 |
| | Canned Peas | | L | D | | 105 | 5 |
| 18 | Yellow and Other Vegetables | | | | | | |
| | Corn on the Cob | | L | D | | 274 | 3 |
| | Buttered Corn | | L | D | | 137 | 14 |
| | Baked Yellow Squash | | L | D | | 127 | 2 |
| | Beets | | L | D | | 95 | 1 |
| | Fried Onion Rings | | L | D | | 146 | 6 |
| | Stewed Tomatoes | | L | D | | 230 | 1 |
| | Black Eyed Peas | | L | D | | 182 | 3 |
| | Buttered Carrots | | L | D | | 86 | 2 |
| 19 | Salads, Vegetable and Green | | | | | | |
| | Chef Salad | | L | D | | 565 | 4 |
| | Cole Slaw | | L | D | | 162 | 1 |
| | Sliced Tomato and Lettuce | | L | D | | 147 | 6 |
| | Tossed Green Salad | | L | D | | 150 | 33 |
| 20 | Salad Dressings | | | | | | |
| | Sour Cream Dressing | | L | D | | 32 | 1 |
| | Blue Cheese Dressing | | L | D | | 30 | 12 |
| | Italian Salad Dressing | | L | D | | 41 | 3 |
| | Thousand Island Dressing | | L | D | | 34 | 18 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 20 | Salad Dressings | | | | | | |
| | French Salad Dressing | | L | D | | 32 | 4 |
| 21 | Fruit | | | | | | |
| | Stewed Prunes | | L | D | S | --- | 0 |
| | Cantalope Melon | B | L | D | S | 377 | 4 |
| | Canned Apricots | | L | D | S | 296 | 1 |
| | Cottage Cheese | | L | D | | 256 | 2 |
| | Fresh Oranges | B | L | D | S | --- | 0 |
| | Half Grapefruit (fresh) | B | L | D | S | 223 | 2 |
| | Fresh Bananas | B | L | D | S | 193 | 10 |
| | Fresh Peaches | | L | D | S | 185 | 7 |
| | Fresh Apples | | L | D | S | 143 | 5 |
| 22 | Cookies, Brownies, Cakes | | | | | | |
| | Chocolate Chip Cookies | | | | S | 108 | 6 |
| | Molasses Cookies | | | | S | 41 | 3 |
| | Devils Food Cake | | L | D | | 100 | 3 |
| | Cheese Cake | | L | D | | 111 | 9 |
| | Chocolate Cookies | | | | S | 151 | 1 |
| | Strawberry Shortcake | | L | D | | 325 | 8 |
| 23 | Pies | | | | | | |
| | Coconut Custard Pie | | L | D | | 138 | 9 |
| | Blueberry Pie | | L | D | | 101 | 8 |
| | Apple Pie | | L | D | | 204 | 6 |
| | Pecan Pie | | L | D | | 167 | 3 |
| 24 | Ice Cream, Pudding, Other Desserts | | | | | | |
| | Orange Sherbet | | L | D | | 144 | 5 |

Availability and Serving Size of Foods (Continued)

| Food Class | Food Items | Available for | | | | Average Serving | Times Selected |
|---|---|---|---|---|---|---|---|
| | | Breakfast | Lunch | Dinner | Snack | | |
| 24 | Ice Cream, Pudding, Other Desserts | | | | | | |
| | Butterscotch Pudding | | L | D | | 136 | 8 |
| | Vanilla Ice Cream | | L | D | | 168 | 7 |
| | Chocolate Pudding | | L | D | | 133 | 2 |
| | Chocolate Ice Cream | | L | D | | 157 | 6 |
| 25 | Snacks, Candy | | | | | | |
| | Lifesavers | | | | S | --- | 0 |
| | M & M Candy | | | | S | 40 | 6 |
| | Peanut Butter Cup Candy | | | | S | 49 | 5 |
| | Sugarless Gum | | | | S | 11 | 1 |
| | Chewing Gum | | | | S | 24 | 13 |
| | Snickers Candy Bar | | | | S | 50 | 1 |
| | Three Muskateers Candy | | | | S | --- | 0 |
| | Milk Chocolate Bar | | | | S | --- | 0 |

## APPENDIX B

## INSTRUCTIONS FOR CONSUMPTION DIARY

The purpose of this diary is to keep track of what you "consume" during each day of isolation. Specifically, we are interested in your consumption of reading materials (things you read), media (things you watch or listen to), and food (things you eat). Your performance on this task will be used to judge the possibility of a more detailed and complete consumption diary.

The diary for each day is quite simple. It contains four pages. One page will cover 3 AM to 9 PM of that day, the second will cover 9 AM to 3 PM, the third 3 PM to 9 PM and the fourth 9 PM to 3 AM. Each page will be divided into three sections, one section for reading materials, one for media, and the other for food.

You should fill out your diary the first thing each day. At this time, you should write down all the consumption of reading materials, media, and foods of the previous day. Do this by first taking the page with "3 AM to 9 AM" typed on top. In the first section of that page, the one marked "READING MATERIALS," write down the name of <u>any</u> book (including your statistics book), magazine, newspaper, or other reading material you read between the hours of 3 AM and 9 AM of the previous day. Beside each name write down the approximate amount of time (in minutes) you spent reading it.

Next, move down to the section marked "MEDIA." In this section, write: (a) the name of any television show you watched between 3 AM and 9 AM of the previous day; (b) the name of any radio program you listened to during that part of the day; and (c) the title of any record album or single you listened to during the same part of the previous day. Beside each name or title, again, write the approximate amount of time (in minutes) you spent watching or listening.

In the third section of that page, marked "FOOD," write the name of any food or beverage you consumed during 3 AM and 9 AM of the previous day. You should give specific names (examples: "fried chicken," not just "chicken"; "Spanish rice," not just "rice"; or "iced tea," not just "tea.") Make sure to record all the foods and beverages you consumed, even such things as gum or water. The <u>only</u> things you do not have to record are condiments, that is, salt, pepper, mustard, ketchup, and the like. You should also indicate in this section the amount of the foods eaten. Do this by

making an estimate of the total weight (in ounces) of each food and beverage you consumed and write it down beside the appropriate food or drink. If it makes sense, you should also record how many of a particular food item you ate. For example, it would make sense to do this for eggs, baked potatoes, and the like, but it would not make sense for such things as peas, mashed potatoes, or french fries.

When you have completed this section, take the next page. It has "9 AM to 3 PM" typed on top. In filling out it and the last two pages, follow the same procedure that was just described for the first page.

In filling out your diary, try to be as accurate as possible. When you are not sure about any particular entry, give whatever information you can. For example, if you cannot recall the name of a particular radio program, record the type of program it was. Or if you cannot remember the name of a food, give the type of food it was, such as meat, vegetable, or fruit.

To give you a picture of how the diary is to be completed examine the attached example of one page from a diary.

## Appendix C

Food Items on Preference Survey List which were not on Menu

Meat loaf
Pepperoni pizza
Milk shake
Cabbage
Grilled cheese sandwich
Buttered Cauliflower
Ham submarine sandwich
Applesauce
Lemonade
Italian cold cut sub. sandwich
Beef stew
Milky Way candy bar
Chocolate milk
T-bone steak
Breaded veal patty
Baked stuffed chicken
Sliced turkey sandwich
Carrot and celery sticks
Barbequed beef sandwich
Bubble gum
Strawberry ice cream
Orange soda
Grilled pork chops
Pinto beans
Canned peaches
American cheese
Scrapple
Turnips
Watermelon
Potatoes au gratin
Spaghetti and meat balls
Brownies
Sugar cookies
Spanish rice
Peas and carrots
Chicken noodle soup
Hash brown potatoes
Clark candy bar
Fried scallops
Chili dog
Sugarless gum
Chicken pot pie
Turkey pot pie
Dr. Pepper soda
Lo Cal soda
Rasberry Sherbert
Chocolate cream pie
Baked ham
Fresh plums
Vanilla wafers
Broiled chicken
Apricot pie
French toast
Chocolate bar with almonds
Corn flakes cereal
Frozen mixed vegetables
Chicken chow mein
Vegetable soup
Chicken salad sandwich
English muffins
Canned green peas
Cheese pizza
Mr. Goodbar candy

Appendix D

Item Name Changes Made to Produce

The "Revised Diary"

| Diary | Changed to | "Revised Diary" |
|---|---|---|
| 2 Ice Cream | | 2 Chocolate Ice Cream |
| 4 Bread | | 4 Dark Bread |
| 1 White Bread | | 1 Dark Bread |
| 2 Bread | | 2 Hot Rolls |
| 1 Bread | | 1 French Bread |
| 1 Hot Rolls | | 1 Baking Powder Biscuits |
| 2 Tea | | 2 Cola |
| 1 Salad | | 1 Cole Slaw |
| 2 Peas | | 2 Canned Peas |
| 1 Cookies | | 1 Chocolate Cookies |
| 1 Orange | | 1 Orange Juice |
| 1 Orange | | 1 Fresh Peach |
| 1 Spinach | | 1 Turnip Greens |
| 1 Sausage | | 1 Bacon |
| 1 Baked Beans | | 1 Lima Beans |

## Appendix E

Definitions and Formulae used in Analysis of Diary Data

I. DATA SOURCES

A. ACTUAL OR CONSUMED - the data collected at the time of consumption on food items actually consumed during experiment by each of the Inner 4 crewmen and the Outer 8 crewmembers for 8 days.

B. RECORDED OR DIARY - the data collected on food items recorded in the daily food consumption diary by each of the Inner 4 crewmen and the Outer 8 crewmembers for 8 days.

C. REVISED DIARY - the data produced after the experiment by making trivial changes in the diary data in order to analyse the more important differences between consumption and recorded consumption.

II. DATA POINTS SELECTED FOR ANALYSIS

A. NUMBER OF SERVINGS - the number of reportings made of each food item in a data source.

B. AMOUNT IN GRAMS - the weight of each food item reported in a data source. In the diaries the weight was estimated in ounces (except Inner crewman 1) and translated into grams for comparison with the actual data.

C. CALORATED AMOUNT - the amount in grams of each reported food item translated into the number of calories for each data source. (Further descriptions for amount in grams are the same for calorated amount).

III. DATA UNITS

A. <u>GROSS UNITS</u> - raw data points summed across days and subjects before comparison between data sources.
   1. NUMBER OF SERVINGS - the number of servings of a food item in a data source summed across days and subjects.
   2. AMOUNT IN GRAMS - the amount in grams of each food item in a data source summed across days and subjects.

B. MOLECULAR UNITS - raw data points for each day, for each subject compared between data sources before summing across days and subjects.
   1. NUMBER OF SERVINGS - the number of servings of a food item in a data source for each day, for each subject.
   2. AMOUNT IN GRAMS - the amount in grams of each food item in a data source averaged for each day, for each subject. If the average for a day is zero in either data source the error for that day is disregarded when summing across days. In this way estimation error is determined, isolated from misrecordings.

IV. FORMULAE DESCRIPTIONS - These data were analyzed for each food item, food class, Food Group, and grand total of all food items. The descriptions below apply to the formulae used for the Food Group Analyses.

A. FORMULAE USING GROSS UNITS OF DATA (See III Above)
   1. GROSS OR TOTAL ACTUAL NUMBER OF SERVINGS - the number of servings in the actual data summed across days and subjects for all food items in all classes within a Food Group.
   2. GROSS OR TOTAL RECORDED NUMBER OF SERVINGS - the number of servings in the diary data summed across days and subjects for all food items in a Food Group.
   3. GROSS OR TOTAL ACTUAL AMOUNT IN GRAMS - the amount in grams in the actual data summed across days and subjects for all food items in all classes within a Food Group.
   4. GROSS OR TOTAL RECORDED AMOUNT IN GRAMS - the amount in grams in the diary data summed across days and subjects for all food items in all classes within a Food Group.
   5. GROSS PERCENTAGE OF THE DIFFERENCE FOR NUMBER OF SERVINGS - the gross recorded number of servings for a Food Group minus the gross actual number of servings for the Food Group, divided by the gross actual number of servings for that Food Group multiplied by 100.
   6. GROSS PERCENTAGE OF THE DIFFERENCE FOR AMOUNT IN GRAMS - the gross recorded amount in grams for a Food Group minus the gross actual amount in grams for a Food Group divided by the gross actual amount in grams for the Food Group multiplied by 100.

B. FORMULAE USING MOLECULAR UNITS OF DATA (See III Above).
   1. ALGEBRAIC SUM OF MISRECORDINGS - the molecular recorded number of servings minus the molecular actual number of servings, summed across days and subjects for all food items in all classes within a Food Group. This sum takes into account whether the misrecording is an understatement (food item in actual data but

not in diary data) or an overstatement (food item in diary data but not in actual data.

2. ARITHMETIC SUM OF MISRECORDINGS - the absolute value of the molecular recorded number of servings minus the molecular actual number of servings, summed across days and subjects for all food items in all classes within a Food Group. This sum, which does not take into account whether the misrecording is an understatement or overstatement, gives the total number of errors in recording food items.
3. ALGEBRAIC SUM OF ESTIMATION ERROR - the molecular (average per day) recorded amount in grams minus the molecular actual amount in grams summed across days and subjects for all food items in all classes within a Food Group. This sum takes into account whether the estimation error is an overestimation or an underestimation.
4. ARITHMETIC SUM OF ESTIMATION ERROR - the absolute value of, the molecular recorded amount in grams minus the molecular actual amount in grams, summed across days and subjects for all food items in all classes within a Food Group. This sum, which does not take into account whether the estimation error is an overestimation or an underestimation, gives the total number of grams in error.
5. ALGEBRAIC AVERAGE PROPORTION OF MISRECORDINGS - the Algebraic Sum of misrecordings for a food item summed across days and subjects, divided by the total number of servings of that food item (actual or recorded, whichever is greater) summed across days and subjects. This proportion is then summed for all food items in all classes within a Food Group and divided by the number of different food items in the Food Group. This proportion is an abstract number which when related to the Arithmetic Average Proportion of misrecordings expresses the imbalance of understatements and overstatements which together make up the total proportion of misrecordings.
6. ARITHMETIC AVERAGE PROPORTION OF MISRECORDINGS - the Arithmetic Sum of misrecordings for a food item summed across days and subjects, divided by the total number of servings of that food item (actual or recorded, whichever is greater) summed across days and subjects. This proportion is then summed for all food items in all classes within a Food Group and divided by the number of different food items in the Food Group. This gives the probability that an individual average food item in the Food Group, appearing in either data source, is in fact misrecorded in the diary.

7. ALGEBRAIC AVERAGE PROPORTION OF ESTIMATION ERROR - the Algebraic Sum of estimation error for a food item summed across days and subjects, divided by the average actual amount in grams of a food item divided by the total number of servings of the food item. This proportion is then divided by the number of days in which the food item was reported in both data sources for a daily average proportion of error per serving. The average proportion is summed for all food items in all classes within the Food Group and divided by the number of different food items in the Food Groups. This gives the proportion of overestimation or underestimation of an average food item in a Food Group when many servings of that food item are considered.
8. ARITHMETIC AVERAGE PROPORTION OF ESTIMATION ERROR - the Arithmetic Sum of estimation error for a food item summed across days and subjects, divided by the average amount in grams per serving obtained by the total actual amount in grams of a food item, divided by the total number of servings of the food item. This proportion is then divided by the number of days in which the food item was reported in both data sources for a daily average proportion of error per serving. The average proportion is summed for all food items in all classes within the Food Group and divided by the number of different food items in the Food Group. This gives the proportion of estimation error in a daily average serving of an average food item in the Food Group.

Example 1 - Algebraic and Arithmetic Sum of estimation error for a single food item.

$$\underline{\text{Algebraic Sum}} \text{ of estimation error} = \sum_{\substack{\text{all days} \\ \text{all Inner 4}}} \left( \frac{\text{recorded amt. for a day}}{\text{recorded no. of servings for a day}} - \frac{\text{actual amt. for a day}}{\text{actual no. of servings for a day}} \right)$$

$$\underline{\text{Arithmetic Sum}} \text{ of estimation error} = \sum_{\substack{\text{all days} \\ \text{all Inner 4}}} \left( \text{ABSOLUTE VALUE} \left( \frac{\text{recorded amt. for a day}}{\text{recorded no. of servings for a day}} - \frac{\text{actual amt. for a day}}{\text{actual no. of servings for a day}} \right) \right)$$

Note: If either the recorded or actual number of servings for a day is zero, that day is disregarded in calculations.

Data on food item, Devil's Food Cake, in Sweets Food Group for Inner 4 crewmen.

| Crewmember | Day | Actual #servings | Actual GMs | Diary #servings | Diary GMs |
|---|---|---|---|---|---|
| 1 | 4 | 1 | 76 | 1 | 20 |
| 4 | 7 | 1 | 103 | 1 | 141 |
| 4 | 8 | 1 | 102 | 0 | 0 |



**Algebraic Sum**

$$\frac{20}{1} - \frac{76}{1} = -56$$

$$\frac{141}{1} - \frac{103}{1} = +38$$

$$-18$$

**Arithmetic Sum**

$$\text{ABSVAL}\left(\frac{20}{1} - \frac{76}{1}\right) = 56$$

$$\text{ABSVAL}\left(\frac{141}{1} - \frac{103}{1}\right) = 38$$

$$94$$

Example 2 - Algebraic and Arithmetic Sum of estimation error for a Food Group.

$$\text{Algebraic Sum of estimation error} = \sum_{\text{all food items in a Food Group}} \left( \text{Algebraic Sum of estimation error for each food item} \right)$$

$$\text{Arithmetic Sum of estimation error} = \sum_{\text{all food items in a Food Group}} \left( \text{Arithmetic Sum of estimation error for each food item} \right)$$

Data on food items in Sweets Food Group for Inner 4 crewmen.

| Class | Food items in Sweets Food Group | Algebraic Sum of estimation error | Arithmetic Sum of estimation error |
|---|---|---|---|
| 22 Cookies Brownies Cakes | Chocolate Chip Cook. | 0 | 0 |
| | Molasses Cookies | 147 | 147 |
| | Devil's Food Cake | -18 | 94 |
| | Cheese Cake | -145 | 153 |
| | Strawberry Shortcake | -535 | 535 |
| 23 Pies | Coconut Custard Pie | 157 | 357 |
| | Blueberry Pie | -123 | 357 |
| | Apple Pie | 173 | 603 |
| | Pecan Pie | -55 | 145 |
| 25 Snacks Candy | M&M Candies | 0 | 0 |
| | Peanut Butter Cup | 222 | 222 |
| | Chewing Gum | -28 | 28 |
| | Snicker's Candy Bar | 94 | 94 |
| | Algebraic and Arithmetic Sum of estimation error for Sweets Food Group = | -111 (Algebraic) | 2735 (Arithmetic) |

Example 3 - Algebraic and Arithmetic Average Proportion of estimation error for a single food item.

$$\text{Algebraic Average Proportion of estimation error} = \frac{\left( \frac{\text{Algebraic Sum of estimation error}}{\left( \frac{\text{gross actual amount}}{\text{gross actual no. of servings}} \right)} \right)}{\text{number of days item is reported in both actual and diary}}$$

$$\text{Arithmetic Average Proportion of estimation error} = \frac{\left( \frac{\text{Arithmetic Sum of estimation error}}{\left( \frac{\text{gross actual amount}}{\text{gross actual no. of servings}} \right)} \right)}{\text{number of days item is reported in both actual and diary}}$$

Data on food item, Devil's Food Cake, in Sweets Food Group for Inner 4 crewmen

| Gross Actual # of servings | Gross Actual Amount in grams | Sum of estimation error Algebraic | Arithmetic | # of Days |
|---|---|---|---|---|
| 3 | 281 | -18 | 94 | 3 |



Algebraic Average Proportion

$$\frac{\left(\frac{-18}{\left(\frac{281}{3}\right)}\right)}{3} = -0.10$$

Arithmetic Average Proportion

$$\frac{\left(\frac{94}{\left(\frac{281}{3}\right)}\right)}{3} = 0.30$$

Example 4 - Algebraic and Arithmetic Average Proportion for a Food Group

FORMULA F 44

$$\text{Algebraic Average Proportion} = \frac{\sum_{\text{All Items In a Food Group}} \left( \text{Algebraic Average Proportion for each Food Item} \right)}{\text{Number of Different Food Items in a Food Group}}$$



FORMULA F 45

$$\text{Arithmetic Average Proportion} = \frac{\sum_{\text{All Items In a Food Group}} \left( \text{Arithmetic Average Proportion for Each Food Item} \right)}{\text{Number of Different Food Items in a Food Group}}$$

Data on food items in Sweets Food Group for Inner 4 crewmen.

13 Different Food Items in Sweets Group

| Class | Food Items in Sweets Food Group | Algebraic Average Proportion | Arithmetic Average Proportion |
|---|---|---|---|
| 22 Cookies Brownies Cakes | Chocolate Chip Cook. | 0.00 | 0.00 |
| | Molasses Cookies | 1.40 | 1.40 |
| | Devil's Food Cake | -0.10 | 0.30 |
| | Cheese Cake | -0.30 | 0.30 |
| | Strawberry Shortcake | -0.50 | 0.50 |
| 23 Pies | Coconut Custard Pie | 0.30 | 0.60 |
| | Blueberry Pie | -0.30 | 0.80 |
| | Apple Pie | 0.30 | 0.90 |
| | Pecan Pie | -0.20 | 0.50 |
| 25 Snacks Candy | M&M Candies | 0.00 | 0.00 |
| | Peanut Butter Cup | 1.60 | 1.60 |
| | Chewing Gum | -0.20 | 0.20 |
| | Snickers Candy Bar | 2.00 | 2.00 |
| | Algebraic and Arithmetic Average Proportions = | $\frac{+4.00}{13} = 0.31$ | $\frac{9.10}{13} = 0.70$ |

Appendix F

Plan of Isolation Laboratory